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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

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VOLUME 55 **JUNE 1952** NUMBER 654

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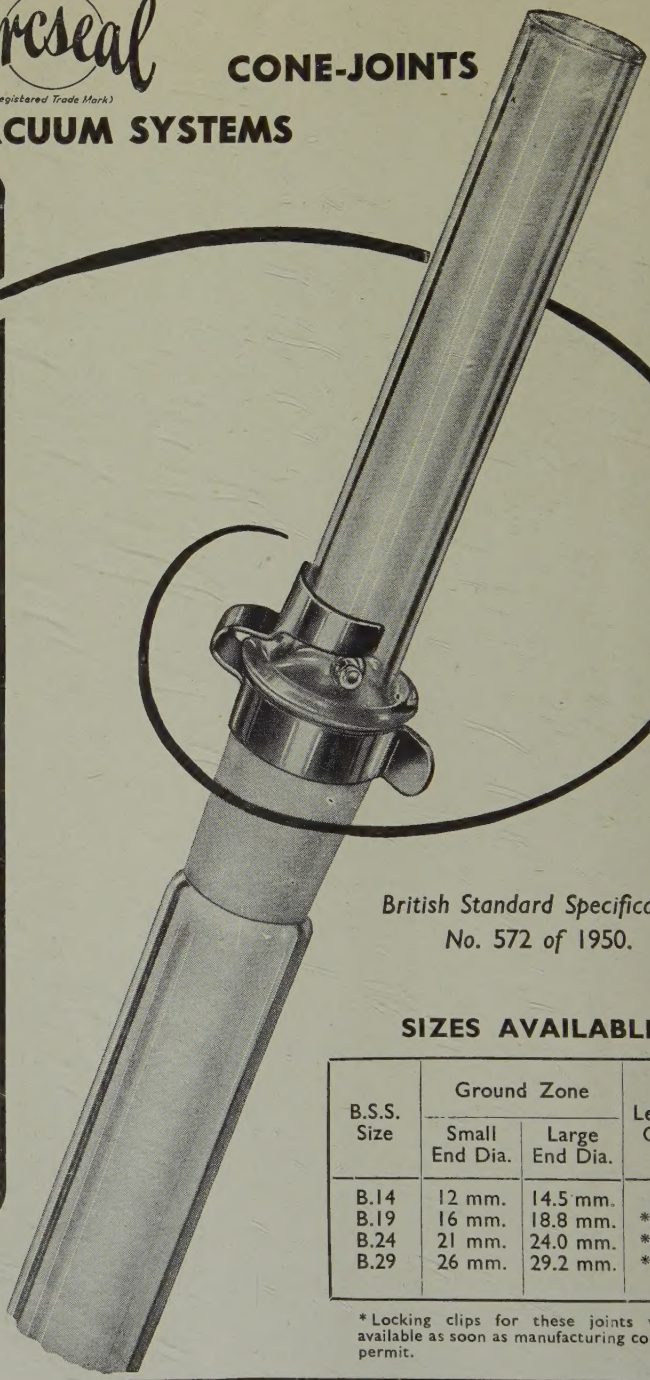

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Mechanical testing
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Applied electrochemistry
Photocells
Thermionic tubes
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Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list, together with the lists published in the preceding issues of the current volume, supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Akad. Tekn. Vidensk. Lydtekn. Lab. Medd.*	*Akademiet for de Tekniske Videnskaber.* Lydteknisk Laboratorium. Meddelelse. 10 Øestervoldgade, Copenhagen.
**Amer. Scientist*	*American Scientist.* Burlington, Vermont.
Bull. Cent. Phys. Nucléaire Brussels	*Bulletin du Centre de Physique Nucléaire de l'Université Libre de Bruxelles.* 50 Avenue F. D. Roosevelt, Brussels.
Dtsch. Elektrotech.	Verlag Technik, Unter den Linden 12, Berlin, N.W.7.
International Electrotechnical Commission Publication	Central Office of the International Electrotechnical Commission, 39 Route de Malagneu, Geneva.
Navy Dep., Taylor Model Basin Rep.	*Navy Department, David W. Taylor Model Basin, Report.* Washington 7, D.C.
**Publ. Obs. Michigan*	*Publications of the Observatory of Michigan.* Ann Arbor, Michigan.
**Quart. J. Math. Oxford (Ser. 2)*	*Quarterly Journal of Mathematics Oxford, Second Series.* Oxford University Press, Amen House, Warwick Square, London, E.C.4.
**Rep. Res. Inst. Elast. Engng*	*Reports of the Research Institute for Elasticity Engineering.* Kyushu University, Fukuoka.

Change of Address

Ingegnere	*L'Ingegnere.* Organo dell' Associazione Nazionale Ingegneri ed Architetti Italiani. Via Calabria 35, Rome.

Notes

Elektrotechnik [*Berlin*]	*Elektrotechnik.* Title changed to *Deutsche Elektrotechnik* [*Dtsch. Elektrotech.*] from the April issue of 1952 to differentiate from the Czechoslovak journal of the same name.
Euclides [*Madrid*]	The journal formerly referenced as *Euclides* will now appear as *Euclides* [*Madrid*] to differentiate from the Dutch journal of the same name.

New Journal

Lab. Pract.	*Laboratory Practice.* United Trade Press, 24 Bride Lane, Fleet Street, London, E.C.3. Monthly. Vol. 1, No. 1 dated April, 1952. Annual subscription £2 5s. 0d. post free. Single copies 4s.

Errata

Author Index (1950), p. 1082, column 1, line 35, COULSON, C. A.: *for* 9115 *read* 9118.
Author Index (1950), p. 1184, column 1, line 82, v. LAUE, M.: *for* 9115 *read* 9118.
Author Index (1950), p. 1192, column 2, line 63, ZHDANOV, V. A. and KONUSOV, V. F.: *for* 9112 *read* 9115.
Author Index (1950), p. 1109, column 1, line 50, HEATH, C. F., LINNETT, J. W. and WHEATLEY, P. J.: *for* 4254 *read* 4245.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose Abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 4236 (1950):	**20**, 924 (*April*, 1952).
Abstr. 907 (1951):	**20**, 759 (*April*, 1952).
Abstr. 8846 (1951):	**20**, 740 (*April*, 1952).
Abstr. 182 (1952):	**85**, 1064–5 (*March* 15, 1952).
Abstr. 467 (1952):	**85**, 1064 (*March* 15, 1952).
Abstr. 535 (1952):	**85**, 1064 (*March* 15, 1952).
Abstr. 1521 (1952):	**20**, 760 (*April*, 1952).
Abstr. 1957 (1952):	(1952) 1185 (*March*).
Abstr. 2014 (1952):	**20**, 756 (*April*, 1952).
Abstr. 2024 (1952):	**20**, 920 (*April*, 1952).
Abstr. 2044 (1952):	**85**, 1064 (*March* 15, 1952).
Abstr. 2155 (1952):	**20**, 927 (*April*, 1952).
Abstr. 2204 (1952):	**20**, 917 (*April*, 1952).

MATHEMATICS 51

517.512 : 621.3.018.3

4080. On the definition of the conventional mean value of a periodic magnitude. V. ZERBINI. *Elettrotecnica*, **38**, 546–7 (*Dec.* 10–25, 1951) *In Italian.*

The accepted definition for symmetrical waves having only two passages through zero per period [Abstr. 3253 (1951)] is extended to unsymmetric waves having more than two passages through zero per period. Practical examples are discussed, based on electromagnetic induction and on rectification. A method of measurement is explained. It seems necessary for the general case to introduce at least two different definitions. R. G. JAKEMAN (R).

517.941

4081. Note on a generalization of Rayleigh's principle. W. J. DUNCAN. *Quart. J. Mech. Appl. Math.*, **5**, 93–6 (*March*, 1952).

A root λ of the characteristic equation of a set of n linear ordinary differential equations with constant coefficients and of order m is also a root of an equation of degree m whose coefficients are quadratic forms in the modal co-ordinates corresponding to λ. It is shown that, when the matrices of each order are symmetric, the root λ of the equation of mth degree is stationary for small deviations of the modal co-ordinates from their true ratios for the mode considered. A.

518.3

4082. Nomogram for determining the real and complex roots of a fourth-order equation. E. BATSCHELET AND H. R. STRIEBEL. *Z. angew. Math. Phys.*, **3**, 156–9 (*No.* 2, 1952) *In German.*

An alignment diagram is proposed instead of a network chart. This procedure allows a higher degree of freedom without additional work. The same method may be used for third order equations. A.

518.5

4083. A computer for correlation functions. F. E. BROOKS, JR AND H. W. SMITH. *Rev. Sci. Instrum.*, **23**, 121–6 (*March*, 1952).

The data to be studied are transcribed on to magnetic tapes. These tapes are then run through a computer which computes the auto- or cross-correlation functions and plots the resulting function through a recording meter. An example of the application of this computer to the study of the turbulence of the atmosphere is shown. A.

518.5 : 621.318.572

4084. Universal high-speed digital computers: serial computing circuits. F. C. WILLIAMS, A. A. ROBINSON AND T. KILBURN. *Proc. Instn Elect. Engrs, Pt II*, **99**, 107–119 (*April*, 1952) [*Paper* 1164].

For abstract see Abstr. 7450 (1951).

518.5 : 778.3

4085. Photographic methods of calculation (eulogismography). C. MILLION. *C.R. Acad. Sci.* [*Paris*] **234**, 313–16 (*Jan.* 14, 1952) *In French.*

Simple methods are described for evaluating certain sums, products and integrals, and finding contour lines of two-dimensional functions. The function is represented by variations in transparency of a negative or mask. A number of interesting applications are suggested. R. H. DAVIES

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.615

4086. Compensation of seeing in photoelectric photometry. W. A. HILTNER. *Observatory*, **71**, 234–7 (*Dec.*, 1951).

In stellar polarization measurements based on p.e. photometry, the "noise" due to scintillation normally restricts the accuracy to *c.* $\pm 0{\cdot}003$ mag. over a time interval of 4 min. By observing the ratio of intensities in two mutually perpendicular directions (one corresponding to plane of polarization) with a suitably designed amplifier circuit it is possible to effectively eliminate the unwanted noise. In such case, the accuracy of determination is limited only by the amount of light-flux available. Twenty-four observations of μ Herc. give for the probable error of a single observation $\pm 0{\cdot}00016$ mag. D. R. BARBER

522.615 : 523.92

4087. Simultaneous photoelectric recordings with two telescopes. A. N. ARGUE AND H. E. BUTLER. Letter in *Observatory*, **72**, 31–3 (*Feb.*, 1952).

Describes the observation of a variable star and a comparison star using two telescopes on the same mounting. The telescopes can be pointed many degrees apart but are driven around together. Each telescope carries its own photocell and has its own galvanometer, these recording on photographic paper moving at 1 cm/min. The precautions taken to secure accurate results are stated and the scatter of the readings is given as 0·007 mag. E. G. MARTIN

523.112

4088. Condensations in expanding cosmologic models. A. RAYCHAUDHURI. *Phys. Rev.*, **86**, 90–2 (*April* 1, 1952).

The consequence of a perturbation in the expanding universe is investigated. It is found that the density gradient decreases with time, while the ratio between the perturbed density and the background density diverges more and more from unity. These results are essentially in agreement with observation and explain why even in "point source" cosmologic models, condensations of extremely high densities are not to be expected at present. A.

523.162

4089. On the excitation mechanism of the 21 cm interstellar hydrogen emission line. S. A. WOUTHUYSEN. Letter in *Physica*, **18**, 75–6 (*Jan.*, 1952).

Absorption and re-emission of the Lyman-α line by H in interstellar space provides an efficient mechanism for establishing temperature equilibrium between the hyperfine spin states and the translational energy, each being related to the line shape in the absence of induced emission. D. H. WHIFFEN

523.165

4090. Radio astronomy. A. B. LOVELL AND J. A. CLEGG. *London, Chapman and Hall* (1952) 235 *pp.*

A general account of radar and radio astronomy, including discussion of some hitherto unpublished investigations of the application of the long-pulse radar technique to the aurora, the planets and the gegenschein. M. W. OVENDEN

523.165

4091. Radio-frequency radiation from the constellation of Cygnus. J. H. PIDDINGTON AND H. C. MINNETT. *Aust. J. Sci. Res. A*, **5**, 17–31 (*March*, 1952).

Observations are described of the radiation from portion of the constellation of Cygnus at frequencies of 1210 and 3000 Mc/s. Two sources of radiation were observed at the lower frequency, one being the well-known "radio star," Cygnus-A. The other was a diffuse source of limited extent which might be called a "radio nebula." Neither source could be observed at the higher frequency. The properties of both sources, particularly their spectra, are discussed and it is shown that earlier discrepancies in observations of the Cygnus region may be explained. The diffuse source coincides in position with the secondary maximum in the lower frequency galactic contours, which Bolton and Westfold [Abstr. 796, 798 (1951)] have interpreted as a spiral arm of the Galaxy. The new evidence suggests that the source is probably due to thermal emission from clouds of ionized interstellar gas, possibly in the region of γ Cygni and having a temperature and electron density of the order of 10^4 °K and 10 cm^{-3} respectively. A.

523.2

4092. The formation of the planets. I. Gravitational condensation. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **14**, 765–75 (*No.* 6, 1950) *In Russian.*

It is shown that, if the sun was formerly surrounded by a cloud possessing the angular momentum and mass of the contemporary planetary system, then in the course of time part of the substance of this cloud, being transformed into solid particles, must have flattened out; on reaching a certain critical thickness, small by comparison with the dimensions of the cloud, it disintegrated into a large number of separate condensates with masses not exceeding the mass of the asteroids. The quasi-statistical theory of the gradual flattening of the cloud in consequence of the decreasing energy of its component particles due to non-elastic collisions is given. To each stage of the process of flattening of the system of particles it is possible to attribute a certain "temperature" θ, depending, generally speaking, on the distance R from the sun and uniquely connected with the dispersing speeds of the particles and the thickness of the cloud. On reaching a critical thickness N_{cr} the cloud becomes unstable and disintegrates into condensates of radius r, in order of increasing N_{cr}. It is shown that at the beginning of condensation the particles are moving with relative speeds of the order of metres/second. The dimensions and masses of condensates, which have their greatest magnitudes in the zone of Jupiter ($m \simeq 3 \times 10^{22}$ g) are calculated. A. L. MACKAY

523.2

4093. The formation of the planets. II. The law of planetary distances and the rotations of the planets. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **14**, 776–89 (*No.* 6, 1950) *In Russian.*

It is shown that from the condensation there appear (in agreement with the conclusion of the first part of the work) as the products of the condensation of the initial cloud, secondary condensations of greater mass, and from the latter the planetary system, possessing properties near to the properties of the contemporary solar system. In the system, consisting of a limited number of bodies, the orbits of these bodies must have become elliptical as a result of their mutual perturbations. During the constant growth of the bodies two processes compete—increase of the eccentricities of the orbits as a consequence of the growth of the mutual perturbations, and decrease in acts of conglomeration. In the early stages of growth the first process predominated, and led to the uniting into the planets; in the later stages the second process predominated and led to the almost circular planetary orbits. From an examination of the eccentricities of the orbits the law of planetary distances is deduced and "the principle of geometrical means," relating the distances from the sun of two planets, distributed symmetrically relative to Jupiter. The conclusions are in satisfactory agreement with observations. The observed data are discussed and comparisons are made of the law of planetary distances with the law of Bode–Titsius. It is shown that the ratio of the angular momentum of a planet around its own axis to that around the sun is function of the mass of the planet only, and this conclusion agrees with observations. A. L. MACKAY

523.2

4094. The formation of the planets. III. The structure of the initial cloud and the separation of the planets to the inside and outside. L. E. GUREVICH AND A. I. LEBEDINSKIĬ. *Izv. Akad. Nauk SSSR*, **14**, 790–9 (*No.* 6, 1950) *In Russian.*

The construction of the initial cloud is investigated and the origins of the differences in the properties of outer and inner planets are examined. It is shown that within the contemporary solar system it was not necessary for gas or dust to have been dissipated, but beyond its border hydrogen must have been dissipated. Consequently, the dimensions of the solar system are determined by the condition for the absence of the dissipation of the hydrogen cloud. The hypothesis of O. Yu. Shmidt on the origin of the primary cloud and the hypothesis of V. G. Fesenkov

lead to the same conclusion, that the immediate neighbourhood of the sun must be almost unfilled by the material of the cloud. The dust cloud at the moment of gravitational condensation had the form of a strongly flattened elliptical toroid, which explains the absence of an intra-mercurial planet. In the inner part of the tore, heated by the sun's rays, only non-volatile substances could exist as dust particles and it was there that the inner planets composed of non-volatile material were formed. In the greater part of the dust cloud the temperature was near to the temperature of interstellar space and thus volatile substances rich in hydrogen, and possibly also molecular hydrogen, entered in the state of dust. As a consequence of the low temperature of the dust particles, practically all the gas from the spherical cloud gradually penetrated into the plane dust system and condensed on the particles, which explains the larger masses and the chemical compositions of the outer planets. The kinetics of formation of the planetary system are examined. The actual process differed from the schemes given in the first part of the article in that the cloud was not regular but contained bodies of various sizes from dust particles up to agglomerates with masses of the order of 10^{27} g.

A. L. MACKAY

523.34

4095. Lunar erosion. K. BUETTNER. *Publ. Astron. Soc. Pacific*, **64**, 11–14 (*Feb.*, 1952).

A brief discussion is given of the information obtained from photometric changes during lunar eclipses and radio observations on the thickness of the lunar surface dust layer. Thermal erosion is considered an unlikely cause of this dust layer; instead, the actions of solar protons, X-rays and ultra-violet light, and cosmic radiation are invoked.

M. W. OVENDEN

523.53

4096. The persistence of meteor trails. L. G. H. HUXLEY. *Aust. J. Sci. Res. A*, **5**, 10–16 (*March*, 1952).

The theory of ambipolar diffusion is applied to the spreading of meteor trails. Application is made to: (*a*) Diffusion from a group strongly localized at $t = 0$. (*b*) Diffusion from a linear concentration. Expressions are developed for the electric field within a diffusing column, and (on certain assumptions) the duration of a trail giving radio echoes.

523.742

4097. Numerical working of the integral equation of darkening at the solar limb. H. MINEUR AND R. PEYTURAUX. *C.R. Acad. Sci.* [*Paris*] **234**, 813–15 (*Feb.* 18, 1952) *In French.*

By means of a numerical integration of the relation, $\phi(\mu) = \int_0^\infty s(\tau)e^{-\tau/\mu}.\frac{d\tau}{\mu}$ where $\phi(\mu)$ is the darkening factor, cf. centre of solar disk, at position angle θ ($\mu = \cos\theta$), values of $s(\tau)$, the ratio of coeff. of emission to coeff. of absorption at optical depth, τ, have been computed for $\lambda = 16\,550$ Å at $\tau = 0, 0{\cdot}1, 0{\cdot}2 \ldots 1{\cdot}1, 1{\cdot}2, 1{\cdot}3$ and $\to \infty$. The plot of $s(\tau)$ versus τ does not show a point of inflexion.

D. R. BARBER

523.77 : 538.615

4098. On the Zeeman effect measurements of the sun's general magnetic field. H. ALFVÉN. *Ark. Fys.*, **4**, 407–10 (*Paper* 24, 1951).

It is concluded that the detection of a general solar magnetic field by Zeeman effect measurements on Fraunhofer lines is invalidated by the existence of a varying magnetic field of the order of a hundred gauss carried by the turbulent elements in the photosphere.

M. W. OVENDEN

523.82 : 535.51

4099. Polarisation of starlight. T. GOLD. Letter in *Nature* [*Lond.*] **169**, 322 (*Feb.* 23; 1952).

The effect observed recently by Hiltner *et al.*, magnitude up to 12% plane-polarization, may be explained by an isotropy of the interstellar absorbing medium, the result of streaming of dust particles, orientated by their passage through the tenuous galactic gas at high (supersonic) speed. D. R. BARBER

523.842

4100. Contribution to the study of a period-eccentricity correlation for visual double-stars. M.-L. LABEUR. *C.R. Acad. Sci.* [*Paris*] **234**, 1129–31 (*March* 10, 1952) *In French.*

By grouping the available material according to the precision of orbit computation, it is shown that the more precise the orbital parameters, the weaker is the correlation of the period, ($\log P$) with the eccentricity, (e). Using all the available data, a corr. coeff., $r = 0{\cdot}62$, is found. For values of $P < 50$ yr, $\log P$ and e appear independent. Omission from the group of long-period orbits of those for which $P > 500$ yr leads to a weakened value of r, as is also the case when the orbital periods are corrected for systematic error. D. R. BARBER

523.852

4101. Publications of the Observatory of the University of Michigan. Volume X. The structure of the Galaxy. *University of Michigan Press* (1951) 84 *pp.*

A symposium held in connection with the dedication of the Heber Dorst Curtis Memorial Telescope, June 22–24, 1950. For abstracts see Abstr. 4102–4112.

523.852

4102. Galaxies—present-day problems. W. A. BAADE. *Publ. Obs. Michigan*, **10**, 7–17 (1951).

See Abstr. 4101 (1952). A summary of the present state of research into the nature of the extragalactic nebulae. Specific problems considered are (i) the luminosity range of galaxies, (ii) the composition of galaxies, and (iii) criteria for recognizing the occurrence of the two different stellar populations. The Andromeda nebula is considered in detail, and the characteristics of our own system as a spiral nebula discussed. The cosmological problem is explicitly omitted. M. S. OVENDEN

523.852

4103. Comparison of rotational motions observed in the spirals M31 and M33 and in the Galaxy. N. U. MAYALL. *Publ. Obs. Michigan*, **10**, 19–24 (1951).

See Abstr. 4101 (1952). Radial velocities of 32 emission condensations in M31 suggest a constant angular velocity of rotation to 70′ from the centre,

with decrease of rotational velocity with distance from the centre for greater distances. Results are compared with computed rotational velocities of galactic Cepheids. A similar velocity distribution is found, but whereas the zone of maximum rotational velocity of M31 is 4½ kpc from the centre, in our system it is 8 kpc. It thus appears that either (i) the main bodies of M31 and the Galaxy are appreciably dissimilar in size, (ii) the accepted distance of 230 kpc for M31 is too small, or (iii) the present simplified analysis of Cepheid velocities is misleading. M. W. OVENDEN

523.852

4104. Galactic distribution of planetary nebulae and Be stars. R. MINKOWSKI. *Publ. Obs. Michigan*, **10**, 25–32 (1951).

See Abstr. 4101 (1952). Search for planetary nebulae at low galactic latitudes has been made with an objective prism and red filter on the Mount Wilson 10-inch refractor. Faint Be stars are distinguished from planetaries by direct photography with the 60- and 100-inch telescopes. 192 new planetaries have been found which, together with 24 found during the (incompleted) survey with the 18-inch Schmidt at Palomar, brings the total of planetaries to 371. These show a marked concentration to the galactic centre. They are assigned to population II, and evidence is presented that planetaries actually within the central bulge of the galaxy are observed. The planetaries form a flattened system, but one with some 3 times the dispersion in galactic latitude of that for the population I Be stars. The effects of interstellar absorption on the statistics is discussed, and the difficulties of deriving photometric distances of planetaries emphasized. The distribution in size of planetary nebulae in the central bulge is derived. M. W. OVENDEN

523.852

4105. Application of the principle of natural groups to the classification of stellar spectra. W. W. MORGAN. *Publ. Obs. Michigan*, **10**, 33–42 (1951).

See Abstr. 4101 (1952). Criteria for spectral classification of stars on low-dispersion spectrograms (1200–100 A/mm) which enable each group of stars to be unambiguously located on a luminosity class-spectral type diagram are discussed in terms of the most suitable criteria for a given dispersion.

M. W. OVENDEN

523.852

4106. Distribution of early type stars of high luminosity near the galactic equator. J. J. NASSAU AND W. W. MORGAN. *Publ. Obs. Michigan*, **10**, 43–50 (1951).

See Abstr. 4101 (1952). A survey of a continuous belt 12° wide along the galactic equator has been made with a 4° objective prism. This paper summarizes the results obtained for the distribution of O-, B- and A-type stars. M. W. OVENDEN

523.852

4107. Utilization of faint star counts at intermediate latitudes. F. D. MILLER. *Publ. Obs. Michigan*, **10**, 51–57 (1951).

See Abstr. 4101 (1952). The value of counts of stars fainter than 15th magnitude for which spectra are not available is examined. It is concluded that such counts will not extend in distance the information on galactic structure gained from spectral surveys, but will furnish data on the distribution of main-sequence stars between 600 and 2000 pcs from the sun. The difficulty of estimating absolute magnitudes, interstellar absorption (by counts of extra-galactic nebulae) and the uncertainties of stellar luminosity functions are emphasized. Observations of stars in the magnitude range 9·0 to 17·5 at galactic latitude 30° between longitudes 45° and 90° are reported and discussed. At this latitude, between longitudes 65° and 75°, no sensible departures from unit density are found for distances from the sun about 1500 pcs, a result consistent with Oort's density distribution derived from faint stars. M. W. OVENDEN

523.852

4108. Dynamical interpretation of velocity distribution and structural details in the Galaxy. B. LINDBLAD. *Publ. Obs. Michigan*, **10**, 59–62 (1951).

See Abstr. 4101 (1952). The basic method of investigating theoretically the velocity distribution in the solar neighbourhood of the Galaxy is outlined. Deviation of the vertex is supposed due to the presence of spiral structure. The theory that a bar such as is observed in barred spirals (considered as a certain mode of density variation which becomes unstable at a certain degree of flattening of the system) incites the formation of spiral structure by its disturbing action on the internal motions of the system is briefly discussed; spiral arms opening out in the direction of rotation are demanded. The Galaxy is compared with the late-type spiral M83. The acceleration of particles from the interior of the system by the disturbing field is suggested as a mechanism for the ejection into the solar neighbourhood of population II high-velocity stars. M. W. OVENDEN

523.852

4109. Some features of galactic structure revealed by stellar motions. A. N. VYSSOTSKY. *Publ. Obs. Michigan*, **10**, 63–66 (1951).

See Abstr. 4101 (1952). The motions in the neighbourhood of the sun are shown to be consistent with Keplerian orbits about the centre of the Galaxy. The product $\overline{M}\sigma_c^2$ (where $\overline{M}$ is the mean mass, and σ_c the velocity dispersion perpendicular to the galactic plane) is found to be approximately constant, ~200, for main sequence stars, indicating equipartion of energy for these stars. For late-type giants, $\overline{M}\sigma_c^2 \sim$ 1500. An analysis of the peculiar velocities of *K*-type giants has been made in terms of orbital inclination to the galactic plane; those with small inclination tend to follow the velocity-pattern of main sequence stars in their neighbourhood, whereas those with large inclination are independent of this pattern. Deviation of the vertex for nearby stars is interpreted in terms of a local structure similar to a spiral arm, the rotation being in the sense of trailing arm. M. W. OVENDEN

523.852

4110. Recent investigations concerning the stellar luminosity function. S. W. MCCUSKEY. *Publ. Obs. Michigan*, **10**, 67–73 (1951).

See Abstr. 4101 (1952). A summary is given of observations of spectral type and colour for 6 Milky-Way fields chosen to be free of obvious surface

irregularities in stellar population. In computing the space densities it is assumed that the stars of a given spectral group have a Gaussian distribution in absolute magnitude about a mean value for each unit volume of space. Luminosity functions for varying distances from the sun are thus deduced from a homogeneous set of data. Interim results are compared with van Rhijn's luminosity functions, reasonable agreement being obtained. M. W. OVENDEN

523.852

4111. H-alpha emission objects in the Magellanic clouds. K. G. HENIZE AND F. D. MILLER. *Publ. Obs. Michigan*, **10**, 75–78 (1951).

See Abstr. 4101 (1952). 392 H-alpha emission objects have been discovered in the two clouds in addition to the 113 previously known. Objects producing a definitely nebulous image are separated; other objects will include small nebulous knots, planetary nebulae, and emission-line stars of various types. Surface distribution confirms previous estimates of angular dimensions of the clouds, and gives good agreement with other data on stellar population for the detailed structural features of the Large Cloud. 22 B stars showing H-alpha emission have a luminosity frequency distribution similar to galactic stars of type cBe. M. W. OVENDEN

523.852

4112. Comparison of the Magellanic clouds with the galactic system. H. SHAPLEY. *Publ. Obs. Michigan*, **10**, 79–84 (1951).

See Abstr. 4101 (1952). The characteristics of dimensions, positions in space, luminosities, stellar content, galactic type and location in the sequence of galaxies for the Magellanic clouds are compared with our Galaxy. The core of the Small Cloud has population characteristics similar to globular clusters and the galactic nucleus; the structure of the Large Cloud resembles a system of type SBc(pec.). The existence of a local cloud of galaxies is questioned; evidence for the existence of a uniform field of dwarf galaxies is presented, spiral structure being confined to the larger systems. M. W. OVENDEN

523.875

4113. The colorimetry of 51 visual double stars. P. MULLER. *C.R. Acad. Sci.* [*Paris*] **234**, 812–13 (*Feb.* 18, 1952) *In French.*

Visual magnitude measures of 51 double stars have been made at 6 diff. λ's using colour filters: from these, colour indices have been computed. For B-type stars, mag. differences can be large whilst colour differences are small, or zero. When the compt. stars are dwarfs, colour diffs. are not always those to be expected from reference to the Russell–Hertzsprung diagram. For 2 red. irreg. variables, η Gem. and α Herc., the companions are equally red giants. In 4 out of 5 giant-giant pairs, the companion is less red than the principal star. Colour differences do not appear related to the separation of the component stars. D. R. BARBER

523.877

4114. On the integration of stellar models in radiative equilibrium. B. QVIST. *Comment. Phys. Math.* [*Helsingfors*] **15**, 139 *pp.* (*Paper* 8, 1950).

A "complete" stellar model is determined by a set of equations giving temperature, pressure and mass distributions, opacity and rate of energy liberation in terms of distance from the centre of the star and of certain stellar parameters. A uni-parametric model would give a mass-luminosity and also a mass-radius relation; a bi-parametric model would give a mass-radius-luminosity relation. The basic assumptions involved in Eddington's stellar model are discussed, and the model is classified as an incomplete bi-parametric model. A "general" model is determined by the equations of gravitational and radiative equilibrium, the relation between pressure and temperature, the Kramers–Eddington absorption law and the expression $\varepsilon = \varepsilon_0 \rho^k T^n$ for energy liberation. This model is uni- or bi-parametric according as ε_0 is regarded as a universal constant or as a stellar parameter. Calculations are made for the case $k = n = 0$, and the corresponding mass-luminosity law is discussed; with mean molecular weight 0·7, an upper limit for stellar masses is found to be ~280 solar units. Numerical integrations are made for the model $k = 2$, $n = 18$, with the parameter $\mu\,[= 4p_R/p_G)_c] = 1$. The model is found to be convectively unstable at the centre. R. A. NEWING

523.877

4115. Reflections on the integration of stellar models. A task suited for modern mathematical machines. G. JÄRNEFELT. *Comment. Phys. Math.* [*Helsingfors*] **15**, 19 *pp.* (*Paper* 18, 1950).

A detailed summary of Qvist's paper (preceding abstract) is given and it is suggested that the calculations for the "general" model might be extended, with the aid of modern calculating machines, to the case $k = 1$, $n = 17{\cdot}5$; an accuracy of 20 digits might be necessary for reliable results. The mass-luminosity and mass-radius relations could be established by repeating calculations for different values of μ.

R. A. NEWING

523.877 : 539.17

4116. Thermonuclear reactions and astrophysics. H. BONDI AND E. E. SALPETER. *Nature* [*Lond.*] **169**, 304–5 (*Feb.* 23, 1952).

A discussion of the various factors controlling nuclear processes in main-sequence stars, and the sequence of nuclear events in their life-histories. Two reactions are of prime importance, (i) proton-proton chain, and (ii) carbon-nitrogen cycle whose net effect is to convert 4 atoms of H–1 into 1 atom of He–4 (all ionized) with liberation of thermal energy amounting to $6{\cdot}2 \times 10^{18}$ erg/gm. For stars like the sun ($T = 14 \times 10^6$K), the energy liberated by each of the above reactions will be approx. the same; for the less luminous stars, reaction (i), and for the highly luminous stars, reaction (ii) will predominate. The effect of these reactions is to diminish the initially high abundance of H, production of nuclear energy ceasing when all H has been used up (in 10^{11} years, for sun). D. R. BARBER

525.35

4117. The variation of latitudes and the movement of the terrestrial poles of rotation. G. CECCHINI. *Bull. Géod., No.* 21, 275–97 (*Sept.*, 1951) *In Italian.*

A study of data from the international latitude stations for 1900–49 [Abstr. 2353 (1951)] is supplemented by an analysis of observations made in

1949–50; the general conclusions of the previous investigation are confirmed. A detailed analysis is also made of latitude observations at La Plata for 1949–50. R. A. NEWING

525.35

4118. A new discussion of the changes in the earth's rate of rotation. D. BROUWER. *Proc. Nat. Acad. Sci.* [*Wash.*] **38,** 1–12 (*Jan.*). Errata, 280 (*March*, 1952).

Three types of rotational changes are observed, viz. (i) a secular decrease of the earth's rate of rotation, due to tidal friction in shallow seas, which produces a lengthening of the day by $0^s{\cdot}00135 \pm 0^s{\cdot}00055$ per century; (ii) seasonal changes of rate which result from fluctuations of atmospheric, and oceanic circulation and cause acceleration from May to November, and retardation from November to May: and (iii) irregular fluctuations of rate whose accumulated effect has amounted to ± 30 sec during the past 300 yrs. The last-named effect is explained, on the basis of computations using artificial fluctuations curves derived from random numbers, as being due to minute, cumulative random changes in the earth's moment of inertia about the axis of rotation. No large, sudden perturbations need be postulated. D. B. BARBER

526.7

4119. Isostatic compensation of light masses situated below the geoid. Application to the interpretation of the isostatic anomalies of the Paris basin. S. CORON. *C.R. Acad. Sci.* [*Paris*] **234,** 977–9 (*Feb.* 25, 1952) *In French.*

Corrections for the isostatic compensation of the light rocks, density $2{\cdot}3$ g/cm^3, of the Paris basin have been applied to the gravity anomalies. A. H. COOK

526.92

4120. Maximum likelihood estimates of position derived from measurements performed by hyperbolic instruments. E. LUKACS. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47,** 197–201 (*Sept.*, 1951).

Certain electronic surveying instruments—referred to as hyperbolic instruments—determine the difference between the distances from two fixed stations to a moving object. Data obtained from a single observation yield one relation between the three coordinates of the moving object and restrict it to a hyperboloid of revolution. To locate a position in space, observations from at least three pairs of stations are needed. If more than three observations are taken, more than three equations for the three coordinates are obtained. In general these equations will not be compatible; it is then a statistical problem to find an estimate for the unknown position. In this paper maximum likelihood estimates are obtained for positions in space derived from such hyperbolic data. A.

PHYSICS 53

53.081.4 : 538.3 : 621.3.081.1

Magnitudes and units in the science of electricity. *See Abstr.* 447–9

FUNDAMENTALS 530.1

530.12

4121. The theory of relativity. C. MØLLER. (International Series of Monographs on Physics.) *London, Oxford University Press* (1952) 254 *pp.*

"Professor Møller's first aim is to provide a textbook for students in the field of relativity. He gives an exposition of what may be called the classical special and general theory of relativity. Great care is taken to make clear the physical meaning of the quantities occurring in this theory by giving a formulation of the general laws in terms of a three-dimensional vector calculus along with the traditional, very elegant but rather formal four-dimensional formulation. Inside this restricted field the author has aimed at giving a complete account, and the results are presented in a form suitable for immediate application."

530.12

4122. The physical significance of a class of metrics. R. TIWARI. Letter in *Curr. Sci.*, **20,** 263–4 (*Oct.*, 1951).

The coefficients of rotation γ_{ijk} vanish for a metric of the form $g_{ij} = 0$ $(i \neq j \neq k)$. In the absence of matter, this condition is found to imply zero electromagnetic field. R. A. NEWING

530.14

4123. An elementary derivation of Eddington's number 10^{78}. G. J. WHITROW. *Nature* [*Lond.*] **169,** 611–12 (*April* 12, 1952).

A world model composed of N "nucleons," each of mass m and radius r, is assumed to have zero total energy (inertial + gravitational). Max. and min. photon energies [Abstr. 4699 (1950)] are equated to the inertial and self-gravitational energies of a nucleon; it is deduced that $\sqrt{N} \sim c^2r/Gm \sim 10^{39}$ if r and m are interpreted as the radius and mass of a proton. By introducing an electron whose inertial energy = its electrostatic self-energy, it is concluded that the ratio of electrostatic to gravitational force between electron and proton $\sim \sqrt{N}$. R. A. NEWING

530.145

4124. On the quantum theory of fields. II. G. WATAGHIN. Letter in *Nuovo Cim.*, **9,** 208–9 (*Feb.*, 1952).

For Pt I, see Abstr. 9265 (1951). A preliminary report of a new treatment of high-energy meson production based on a non-local field theory containing a critical length l and a new uncertainty relation connected with this. R. H. DALITZ

530.145

4125. The difficulties of divergences for a specific quantized field model. L. VAN HOVE. *Physica*, **18** 145–58 (*March*, 1952) *In French.*

It is well known that for a neutral scalar field in

scalar interaction with infinitely heavy, fixed point sources, the stationary states can be determined exactly. This simple case of quantized field is considered for the discussion of the following two problems: to investigate the origin of the divergence difficulties which are unavoidably brought in when the interaction is treated as a perturbation, and to see how good a description of the exact solution is obtained from the perturbation method as improved by the renormalization technique for discarding divergences. The origin of the divergences is found to lie in the fact that the stationary states of the field interacting with the sources are no linear combinations of the stationary states of the free field. The former are not contained in the Hilbert space spanned by the latter (they even turn out to be orthogonal to this space). A similar property is shown to hold for the more realistic case of two interacting fields under the mere assumption that stationary states exist in presence of interaction. Regarding the second problem, whereas the exact solution and the results obtained by perturbation and renormalization methods are in agreement for the S matrix, they are found to disagree for the unitary matrix $S(t)$ expressing the change of the wave vector between times $t = -\infty$ and t finite. A.

530.145

4126. Current fluctuations in quantum electrodynamics. E. CORINALDESI. Letter in *Nuovo Cim.*, **9,** 194–5 (*Feb.*, 1952).

The vacuum-expectation value $(J_{\mu\nu})$ of $\{J_\mu, J_\nu\}/2$ (J_μ, is the current vector) is evaluated for a finite space-time volume. When the time-smearing width is $\ll 1/m$, $J = J_{11} = J_{22} = J_{33}$ is independent of the spatial width b, whereas J_{00} depends logarithmically on b [Abstr. 9267 (1951)]. The reason for this difference in behaviour is investigated in detail.

R. H. DALITZ

530.145

4127. Dirac's new electrodynamics. E. SCHRÖDINGER. Letter in *Nature* [*Lond.*] **169,** 538 (*March* 29, 1952).

By a change of gauge, the Gordon–Klein–Schrödinger field equations for the electromagnetic potentials and charge-scalar can be put in a form corresponding to Dirac's new equations [Abstr. 981 (1952)]. R. A. NEWING

530.145

4128. Long-range proton-proton tensor force. N. F. RAMSEY. Letter in *Phys. Rev.*, **85,** 937 (*March* 1, 1952).

A comparison between the measured value of the tensor interaction between two protons (as found by means of magnetic resonance experiments on molecular H) and the value calculated from nuclear resonance experiments and spectroscopic data shows that the nuclear part of this interaction is very small, corresponding, for two protons $2{\cdot}8\times10^{-13}$ cm apart, to a potential < 2 eV. L. PINCHERLE

530.145

4129. On collisions between atoms and electrons. S. KICHENASSAMY. *C.R. Acad. Sci.* [*Paris*] **234,** 1035–6 (*March* 3, 1952) *In French.*

It is proposed to study collisions between electrons and atoms supposing the system to form a "complex," as is the case for many nuclear reactions.

R. H. DALITZ

530.145

4130. Radiative correction for the collision loss of fast particles. J. M. JAUCH. *Phys. Rev.*, **85,** 950–2 (*March* 15, 1952).

The correction for the collision loss of fast heavy particles because of the interaction with the radiation field is calculated approximately. The radiative corrections always result in a decrease of the collision loss. Only the collisions with energy loss $\varepsilon > \gamma mc^2$ contribute significantly to this result. For $\gamma = 1000$ and $Z = 18$ (argon) the correction amounts to about 6%. A.

530.145

4131. The interaction of a charged pi meson with the deuteron. W. B. CHESTON. *Phys. Rev.*, **85,** 952–61 (*March* 15, 1952).

The radiative absorption, charge-exchange scattering, elastic and inelastic scattering of a π^+ meson by the deuteron are calculated in conventional weak-coupling theory for the pseudoscalar field with both direct and gradient coupling. The nucleon-nucleon interaction is treated phenomenologically and the "impulse" approximation employed. The behaviour of the ratio $\sigma_{\text{nonradiative}}/\sigma_{\text{radiative}}$ for the *ps.* theory is different from that for the *pv.* theory. The charge-exchange scattering of a *ps* meson exhibits a minimum for forward scattering for both types of coupling but otherwise mirrors the behaviour of the charge-exchange cross-section for a neutron target. The elastic and inelastic scattering cross-sections are comparable for an incident 25-MeV meson and small energy transfers to the deuteron are favoured, in contrast to the case in which the target nucleus is more complex. A.

530.145

4132. The graphs for the kernel of the Bethe-Salpeter equation. C. A. HURST. Letter in *Phys. Rev.*, **85,** 920 (*March* 1, 1952).

The number of irreducible graphs of order n, in the sense of Bethe-Salpeter [Abstr. 1469 (1952)] is shown to lie between two limits, each asymptotically approaching $\frac{1}{2}(n/2)!n!$ for large n. R. H. DALITZ

530.145

4133. The renormalization of meson theories. P. T. MATTHEWS AND A. SALAM. *Rev. Mod. Phys.*, **23,** 311–14 (*Oct.*, 1951).

A brief account is given of Dyson's proof of the finiteness after renormalization of the matrix elements for scattering processes (S-matrix elements) in electrodynamics (interaction of photons and electrons). It is shown to which meson interactions this proof can be extended and some of the difficulties which arose in this extension are discussed. A.

530.145

4134. High energy nucleon-deuteron scattering. P. B. DAITCH AND J. B. FRENCH. Letter in *Phys. Rev.*, **85,** 695 (*Feb.* 15, 1952).

It is shown that for the case of central potentials of arbitrary exchange character, the nucleon-deuteron differential cross-section can be written in terms of

the elementary cross-sections. Considerable arbitrariness can be allowed in calculating the nucleon-deuteron cross-section, as nucleon-nucleon scattering measurements do not give the singlet and triplet amplitudes separately nor their relative phases. The proton-deuteron elastic scattering cross-section is calculated and shows good agreement with the experimental value except in the backward direction.

J. HUGHES

530.145

4135. On the relativistic theory of nuclear forces. I. General theory. II. Equivalence with the formalism of Bethe and Salpeter. M. LEVY. *C.R.Acad. Sci.* [*Paris*] **234,** 815–17 (*Feb.* 18); 922–4 (*Feb.* 25, 1952) *In French.*

The non-adiabatic method of Tamm–Dancoff is extended to arbitrary interaction, for arbitrarily large numbers of particles present in intermediate states. The special cases of restriction to no pairs, and to one meson with arbitrary number of pairs are considered further. It is also shown that this method will lead to results identical with those obtainable from the covariant Bethe–Salpeter equation. R. H. DALITZ

530.145

4136. On certain functional transformations of the equation of evolution. A. VISCONTI. *C.R. Acad. Sci.* [*Paris*] **234,** 817–19 (*Feb.* 18, 1952) *In French.*

The form of the equation of evolution for the *S*-matrix in positron theory is discussed after Fourier transformation, and after a certain unitary transformation. Also, the equation $\dot{U} = \{\mathscr{L}_0 + \mathscr{L}_1\}\ U(t, t_0)$ is transformed into an integral equation whose kernel is expressed in terms of $\mathscr{L}_0$. R. H. DALITZ

530.145

4137. A convergent *S*-matrix formalism with correspondence to ordinary quantum mechanics. P. KRISTENSEN AND C. MØLLER. Letter in *Phys. Rev.*, **85,** 928 (*March* 1, 1952).

Summarizes a gauge-invariant *S*-matrix theory based on a non-localized meson-nucleon interaction Lagrangian involving a covariant form factor. Particle self-energies and vacuum polarization by an external meson field are finite in this theory. Only for high energy processes are deviations from the cross-sections of the usual theory to be expected.

R. H. DALITZ

530.145

4138. Variational calculation of scattering cross sections. E. GERJUOY AND D. S. SAXON. Letter in *Phys. Rev.*, **85,** 939 (*March* 1, 1952).

An attempt to assess the utility of Schwinger's variational formulation of the scattering problem when *ka* is so large that phase shift analysis is slowly converging was carried out in closed form for square well and Yukawa potentials. Considerable improvement over the Born approximation was found.

W. J. SWIATECKI

530.145

4139. Invariance conditions on the scattering amplitudes for spin ½ particles. L. WOLFENSTEIN AND J. ASHKIN. *Phys. Rev.*, **85,** 947–9 (*March* 15, 1952).

The most general form of the scattering matrix in spin space for two spin ½ particles is derived subject to invariance under rotation, reflection and time-reversal. The result may be used to prove a relationship important for polarization experiments and previously stated without proof. A.

530.145

4140. The calculation of perturbations in quantum theory. M. MAYOT. *C.R. Acad. Sci.* [*Paris*] **234,** 920–1 (*Feb.* 25, 1925) *In French.*

A recurrence procedure is given for the formation of the characteristic polynomial of an arbitrary matrix. R. H. DALITZ

530.145

4141. On the calculation of the wave functions in a Coulomb field for anomalous scattering. D. WISKOTT. *Z. Phys.*, **131,** 320–5 (*No.* 3, 1952) *In German.*

Uses Langer's generalization [*Phys. Rev.* **51,** 669 (1937)] of the WKB method. The difficulties occurring when the classical turning point is near to the reaction radius at which boundary conditions are to be applied, is avoided by using Langer's method of continuation past this singularity of the WKB solution. Results are illustrated by use of the figures appropriate to α-scattering by O^{16}. R. H. DALITZ

530.145

4142. Contribution to the quantum theory of light scattering. N. G. VAN KAMPEN. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **26,** 77 *pp.* (*No.* 15, 1951).

For a non-relativistic electron coupled with the electric dipole components of the radiation field, a Hamiltonian containing only its observed mass *m* and observed charge *e*, and valid to all orders in *e*, is constructed following Kramers' suggestion [*Solvay Congress Report*, Brussels (1948)]. For zero external field, the Hamiltonian is transformed to that of an infinite set of oscillators, one of which has imaginary frequency; excitation of this oscillator leads to runaway solutions, therefore it is plausibly discarded. A rigorous solution is given also for harmonic external potential; for the general case, the influence of the external binding on the electron-radiation interaction is treated by perturbation theory. The scattering of light by a bound electron is discussed by a stationary method, in which the phase shift between outgoing and ingoing waves is calculated—spontaneous emission is described by superposition of these stationary states. The Raman scattering and its reaction on the Rayleigh scattering are also discussed in some detail. For resonant scattering the line shape is obtained, and the Lamb-shift of the line in this theory is shown finite. (However, major contributions to this arise from such high frequencies that this theory is not appropriate physically.)

R. H. DALITZ

530.162 : 533.7

4143. The densities of degenerate gases in potential fields. H. ROBL. *Acta Phys. Austriaca*, **5,** 202–13 (*No.* 2, 1951) *In German.*

Formulae are derived from which the density of a gas in a potential field can be calculated when the velocity distribution of the particles in a force-free region is known. The method is applied to degenerate gases obeying the Bose–Einstein or Fermi–Dirac statistics. T. C. TOYE

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531

4144. A program of physical research in classical mechanics. C. A. TRUESDELL. *Z. angew. Math. Phys.*, **3**, 79–95 (*No.* 2, 1952).

A general survey of classical mechanics in which it is suggested that the axioms should be phrased in terms of continuous media rather than mass points. The beginnings of new avenues in classical mechanics are described and a number of suggestions for future research are made. T. C. TOYE

531.22

4145. On the combination of the principles of area-moment and superposition. A. W. SIMON. *Amer. J. Phys.*, **20**, 78–80 (*Feb.*, 1952).

The generalized area-moment propositions developed by the author are combined with the principle of superposition to produce an alternative set of generalized area-moment propositions, which are exteremely simple and convenient in application. The method is illustrated by treating in detail two standard cases in beam theory. The method can also be applied advantageously to the solution of statically indeterminate beams. A.

531.25

4146. Summarized proceedings of a conference on stress analysis, Liverpool, 1951. E. K. FRANKL. *Brit. J. Appl. Phys.*, **3**, 105–14 (*April*, 1952).

At this conference of the Stress Analysis Group of The Institute of Physics 9 papers were read: *Numerical methods in stress analysis, with special reference to the relaxation method*, D. G. Christopherson; *The use of electric resistance strain gauges for the measurement of transient forces in power looms*, R. G. Wolfenden; *Development of very short strain gauge and brittle lacquer techniques in France*, H. de Leiris; *Fatigue*, D. G. Sopwith; *The determination of residual stresses by means of electric resistance strain gauges*, R. G. Boiten; *The application of the "frozen stress" method of photoelasticity to the analysis of a buttress dam*, A. W. Hendry and J. K. Tattersall; *Stress analysis of pipe flanges by the photoelastic method*, G. Robertson; *The application of test loading by hydraulic power*, R. G. Hoare and K. G. Hancock; *Edge stresses on free boundaries of photoelastic models*, H. G. Edmunds. 11 refs.

531.259.2

4147. Large elastic deformations of isotropic materials. IX. The deformation of thin shells. J. E. ADKINS AND R. S. RIVLIN. *Philos. Trans A*, **244**, 505–31 (*No.* 888, 1952).

For Pt VIII, see Abstr. 5826 (1951). The theory of the large elastic deformation of incompressible isotropic materials is applied to problems involving thin shells. The inflation of a circular diaphragm of such a material is studied in detail. It is found that the manner in which the extension ratios and curvatures vary in the immediate neighbourhood of the pole of the inflated diaphragm can be determined analytically. However, in order to determine their variation throughout the inflated diaphragm a method of numerical integration has to be employed. Although this is, in principle, valid for any form of the stored-energy function, the calculations are carried through only for the Mooney form. Finally, the problem of the inflation of a spherical balloon, which has already been dealt with by Green and Shield [Abstr. 7543 (1950)], is discussed in further detail. A.

531.311

4148. A study of a new arresting device for Fletcher's acceleration apparatus. W. G. WADEY. *Amer. J. Phys.*, **20**, 211–12 (*April*, 1952).

A new mechanism for rapidly absorbing the kinetic energy of the cart in Fletcher's apparatus is described, and experiments to determine the physical basis of its operation are discussed. It is shown that the energy is absorbed by viscous flow. A.

MECHANICAL MEASUREMENTS 531.7

531.715.1 : 539.234

4149. The arrangement for the measurement of small film thicknesses. G. C. MÖNCH. *Optik*, **8**, 550–60 (*No.* 12, 1951) *In German.*

A description is given of optical arrangements for measuring thin film thicknesses by making use of the interference double prism of Kösters. Methods are described whereby the thicknesses of evaporated metal films and also of thin celluloid films and varnish films can be made. Full constructional details are supplied for the mounting. Measurements can be made with white light or with monochromatic light. S. TOLANSKY

531.715.2 : 535.822

4150. An investigation into the variation with radius of the error in diameter which arises in the image formed by a microscope of spherical selenium particles. F. HELML AND J. A. SCHEDLING. *Acta Phys. Austriaca*, **5**, 237–9 (*No.* 2, 1951) *In German.*

The measurement of the diameter of small particles of about 6×10^{-5} cm by means of a microscope introduces a large diffraction error. From measurements on double particles of selenium an estimate of this error and its variation with particle size has been obtained. R. W. FISH

531.717.32

4151. A new method of measuring the depth of haemacytometer counting chamber cells. L. O. C. JOHNSON. *J. Sci. Instrum.*, **29**, 130 (*April*, 1952).

The depth of a haemacytometer counting chamber is measured by means of a rocker, supported by the base of the chamber, with two arms which may be rested in turn on the flanking surfaces to the left and right of the chamber. The angular displacement of the rocker between these two positions of rest is measured by an autocollimator. The accuracy of measurement is about $\pm 0{\cdot}2\ \mu$. A.

531.775 : 621.317.39

4152. Tachometer pickup device. I. GOTTLIEB. *Electronics*, **25**, 146, 150, 154 (*Feb.*, 1952).

A small permanent magnet is fixed to a wheel

carried on the shaft whose angular velocity is to be measured. The pick-up device is a subminiature tetrode mounted close to the wheel. Its control grid is run slightly positive, while anode and screen potentials are low, that of the anode being lower, so that a repelling action is obtained. This arrangement causes a large number of low-velocity electrons to flow towards the screen. The field due to the permanent magnet modulates this current by deflection, so that pulses are obtained at a frequency $\propto$ shaft speed. W. G. STRIPP (R)

531.787

4153. Apparatus for imposing and measuring rapid pressure changes in gases. K. P. COFFIN AND S. H. BAUER. *Rev. Sci. Instrum.*, **23**, 115–18 (*March*, 1952).

A simple apparatus is described in which rapid volume changes can be imposed on a small reaction vessel by means of a bellows and cam arrangement. Thus pressure increments of the order of 10 mm Hg can be induced in about 2 msec. The pressure changes during the expansion or compression, and the subsequent adjustment to equilibrium in case the vessel is filled with a dissociating gas, are followed by a Massa Sound pick-up (piezoelectric unit). The sensitivity of the apparatus is such that a $\Delta p = 6{\cdot}7$ mm gives an inch deflection on the oscilloscope. Limitations of the present design, and possible improvements for increased stability and sensitivity are discussed. A.

MECHANICS OF FLUIDS 532

532.13

4154. Problems of cross-viscosity. I. BRAUN AND M. REINER. *Quart. J. Mech. Appl. Math.*, **5**, 42–53 (*March*, 1952).

Reiner's equation [*Amer. J. Math.*, **67**, 350 (1945)] of a general viscous liquid, which differs from Stokes's equation by a quadratic term defining a "coefficient of cross-viscosity" is integrated for the cases of (i) a cylindrical rod rotating in a liquid; (ii) the rotating coaxial cylinder viscometer; (iii) the tube viscometer; (iv) the parallel-plate/torsional viscometer, thus providing criteria for crucial experiments to decide whether the "centripetal effect" in certain liquids is totally or partially due to cross-viscosity. In (iii) the wall pressure should be greater than the Newtonian hydrodynamic pressure by a term involving the ordinary shear viscosity. In (iv) a parabolically distributed pressure upon the plate, which vanishes at a distance from the axis of rotation which is $1/\sqrt{3}$ times the radius of the plate, should be present. A.

532.137 : 621.317.79.083.2

4155. Vibrating-plate viscometer. J. G. WOODWARD. *Electronics*, **25**, 98–100 (*Feb.*, 1952).

A circular steel plate 0·2 in dia. and 0·01 in thick is fixed to an electromagnetically driven reed so that the plate oscillates in its own plane. A $BaTiO_3$ block is mounted on each side of the reed to form a piezoelectric transducer to measure the amplitude of oscillation, which, with a constant driving current, is $\propto$ the damping force exerted by the liquid in which the plate is immersed. The output from the transducer is amplified and itself provides the current driving the reed, thus forming a self-oscillating system. The circuit is so arranged that the current is const. and the operating frequency is always that at which the vibrating system is resonant, this frequency varying slightly for different liquids. The output of the transducer is measured by a valve-voltmeter. Calibration is carried out by adjusting the gain of the v.v. to give full scale reading with the plate vibrating in air. Then various liquids with known values of $\eta\rho$ are used, ρ being the density and η the viscosity. Measurements of $\eta\rho$ from 0·1 to 10^5 can be made, and volumes of liquid as small as 0·5 ml may be used. W. G. STRIPP (R)

532.51

4156. The kinetic energy of a flow possessing a velocity-surface of discontinuity. P. CASAL. *C.R. Acad. Sci.* [*Paris*] **234**, 804–6 (*Feb.* 18, 1952) *In French.*

"Minimum" principles associated with the names of Hamilton and Maupertius are briefly referred to, and the following theorem relating to fluid flow is established: If the permanent flow of an incompressible, non-viscous fluid about an obstacle S comprises a surface of discontinuity Σ, and if its kinetic energy is a minimum in relation to every flow possessing the same conditions at infinity and at a surface of discontinuity Σ' near Σ, then the flow is irrotational outside Σ, and Σ is an isopeistic surface. J. S. G. THOMAS

532.51

4157. General equations of space-time correlations in a turbulent fluid. J. BASS. *C.R. Acad. Sci.* [*Paris*] **234**, 806–8 (*Feb.* 18, 1952) *In French.*

The concept of space-time correlations is introduced into the theory of homogeneous, stationary turbulence. Isotropy with regard to axes of the fluid is defined, and the fundamental differential equations relating to double and triple correlations are derived. These play, in the theory of space-time correlations relating to turbulence, a rôle analogous to the Karman–Howarth equation of propagation relating to the decrease of space correlations in the non-stationary case. J. S. G. THOMAS

532.51

4158. The local structure of space-time correlations in a turbulent fluid. J. BASS. *C.R. Acad. Sci.* [*Paris*] **234**, 1033–4 (*March* 3, 1952) *In French.*

In continuation of the work reported in the preceding abstract, making assumptions that the fluid is incompressible, and turbulence is homogeneous, isotropic, and, in the first case, stationary, a local solution of the general equations of motion relating to double and triple space-time correlations is obtained. If the turbulence is isotropic and stationary, solutions exist only when viscosity is negligible. When the stationary character of the turbulence is abandoned, solutions, analogous to those obtained for the stationary case, but valid without any restrictions, are readily obtained. J. S. G. THOMAS

532.516

4159. Studies in Newtonian flow. IV. Viscosity *vs* molecular weight in liquids; viscosity *vs* concentration in polymer solutions. A. K. DOOLITTLE. *J. Appl. Phys.*, **23**, 418–26 (*April*, 1952).

For Pt III, see Abstr. 3335 (1952). The molecular weight/free-space function applicable to *n*-paraffins $m = 100$ through $m = 240$ at various temperatures is further generalized to apply to homologous series of all Newtonian liquids at constant temperature. The resulting molecular weight function thereby loses some fidelity, and the slopes and intercepts no longer have physical significance. The generalized logarithmic decrement equation nevertheless reproduces viscosity data over extended ranges of molecular weight (at constant temperature) far better than expressions previously proposed. The equation is extended to apply to mixtures of liquids and finally to polymer solutions. A.

532.594

4160. General linearized theory of the effect of surface films on water ripples. II. R. DORRESTEIN. *Proc. K. Ned. Akad. Wet. B*, **54**, 350–6 (*No.* 4, 1951).

For Pt I, see Abstr. 7594 (1951). The theory is in reasonably good agreement with available experimental results. The possible effects of finite amplitude and of turbulence are discussed in general terms.

J. G. OLDROYD

CAPILLARITY 532.6

532.61 : 539.133

4161. Surface tensions and covalent radii. J.-F. JOLIET. *C.R. Acad. Sci.* [*Paris*], **234**, 428–30 (*Jan.* 21, 1952) *In French.*

The plot of surface tensions of compounds $C_nH_{2n+1}X$ (X a halogen atom) with constant *n* against covalent radii of *X*, is a straight line. For various *n* these lines are concurrent at the limiting tension of 32·5 dyne/cm. J. JACOBS

532.613.4 : 541.183

4162. Time-dependence of boundary tensions of solutions. II. Experimental determination of the kinetics and equilibrium of adsorption at liquid-liquid interfaces. A. F. H. WARD AND L. TORDAI. *Rec. Trav. Chim. Pays-Bas.* **71**, 396–408 (*March*, 1952).

For Pt I, see Abstr. 2791 (1946). Boundary tensions have been measured by the method of pendent drops for the interfaces between water and solutions of long-chain fatty acids in hexane over a wide range of concentrations. At low concentrations the interfacial tensions were independent of the age of the surface. But above what appeared to be a critical concentration, characteristic of each fatty acid, the interfacial tensions decreased with time to final equilibrium values. For very low concentrations, below about 5×10^{-5} molal, the interfacial tension decreased linearly with concentration, the slope of the curve being identical for all the acids investigated (lauric, palmitic and stearic). In the concentration range where a time-effect was observed, the fall in interfacial tension, and the time interval during which the fall occurred, both increased with increasing concentration. Experiments were carried out on the effect of varying temperature on the time-effect. It was also shown that time-effect occurred with an ester (ethyl palmitate). A.

532.62

4163. Liquid films formed by means of rotating disks. B. E. DIXON, A. A. W. RUSSELL AND J. E. L. SWALLOW. *Brit. J. Appl. Phys.*, **3**, 115–19 (*April*, 1952).

A study is made of liquid films ejected from the rims of rotating disks with liquid supplied at the centre. The variation in film area with alteration in experimental conditions is best explained by the assumption of a limiting film thickness, the "breaking thickness," for each liquid, below which the film can no longer exist unsupported in the air in the face of disruptive forces. This assumption is supported by experimental evidence including a study of the paths of liquid particles and liquid films before and after leaving the rotating disk, and a rough measurement of film thickness. A distinction is made between films tending to ellipsoidal shape whose peripheral thicknesses vary within fairly wide limits, and substantially horizontal films whose dimensions are governed by the "breaking thickness" of the liquid concerned. The mechanism of the formation and destruction of these liquid films is discussed and differences in the behaviour of water and glycol examined. A.

532.623

4164. Relation of volume of bubble to diameter of orifice at which it is formed. P. C. NEWMAN AND P. F. WHELAN. Letter in *Nature* [*Lond.*] **169**, 326–7 (*Feb.* 23, 1952).

The ratio v/d has been determined for bubbles of air blown very slowly at an orifice of glass with d varying from 0·474 to 0·0131 cm (v = vol. of bubble, d = dia. of orifice). v/d stays constant at 0·19 cm (cf. theory = 0·231) except for the smallest orifices where the bubbles can no longer cling, even momentarily, to the surface. S. J. GREGG

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

4165. A note on hole theory of liquid. T. SATO AND S. ONO. Note in *J. Phys. Soc. Japan*, **6**, 410–11 (*Sept.–Oct.*, 1951).

A numerical error in a previous paper [*J. Phys. Soc. Japan*, **4**, 103 (1946)] is corrected, the amended results being in agreement with those of other workers.

T. C. TOYE

532.7

4166. On the properties of fluorocarbon and polysiloxane fluids. A. BONDI. *J. Phys. Coll. Chem.*, **55**, 1355–68 (*Nov.*, 1951).

The intermolecular force constants of a fluorocarbon and of several polysiloxanes were calculated from their respective polarizability and diamagnetic susceptibility data. The exceptional smallness of the latter constants appears to be due to the large fraction of ionic bonding in these compounds as compared to the bonding in other organic molecules. For these

liquids $(\partial E/\partial V)_T/(\Delta E_v/V) \simeq 1{\cdot}3$ and not 1, as for "normal" liquids. Stefan's number (ratio of heat of vaporization to total surface energy) is of the same order as for "normal" nonassociating liquids (3·2–3·5), suggesting that the type of packing is not different from that prevailing in ordinary liquids, and that the low surface tension reflects only the low cohesive forces. Comparison of the free volumes calculated from sound velocity with those from vapour pressure leads to surprisingly high values of the (free-angle ratio)$^{-1}$, i.e., to a surprising lack of (external) rotational freedom in the liquid state. The extreme stiffness of the fluorocarbons and the dipole interaction of the polysiloxanes are held responsible for this effect. Vapour pressures (or boiling points) of these and "normal" liquids can be correlated to a first approximation on the basis of intermolecular forces (polarizability). Better correlation requires consideration of the effects of restricted external rotation. The dynamic properties, thermal conductivity, and viscosity appear to be determined more by the molecular flexibility or rigidity than by the magnitude of the cohesive energy. A relation between thermal conductivity and the pressure coefficient of viscosity is described. The approximate nature of the theories employed should always be kept in mind in the perusal of the data and the conclusions derived from them. A.

532.77

4167. On the temperature of minimum compressibility of ionic solutions. V. S. VENKATASUBRAMANIAN. Letter in *Curr. Sci.*, **20**, 291–2 (*Nov.*, 1951).

An attempt at understanding the effect of dissolved ions on water structure by measuring the lowering of the temperature of minimum compressibility for solutions of KCl and Na_2CO_3. T. C. TOYE

532.77 : 530.162 : 532.13

4168. The effect of the Brownian motion on the viscosity of solutions of macromolecules. I. Ellipsoid of revolution. N. SAITÔ. *J. Phys. Soc. Japan*, **6**, 297–301 (*Sept.–Oct.*, 1951).

Previous theories on the effect of the Brownian movement on the viscosity of solutions are criticized and a new theory is put forward. The case of the ellipsoid of revolution is considered. T. C. TOYE

532.77 : 530.162 : 532.13

4169. The effect of the Brownian motion on the viscosity of solutions of macromolecules. II. Rigid chain molecules. N. SAITÔ. *J. Phys. Soc. Japan*, **6**, 302–4 (*Sept.–Oct.*, 1951).

The theory of Pt I used for rigid chain molecules. In both cases only the macro Brownian motion affecting the orientation of the molecules is considered. T. C. TOYE

MECHANICS OF GASES 533

533.15 : 537.534.72

4170. The influence of fractionizing and viscosity effects in mass spectrometric gas handling systems. J. KISTEMAKER. *Physica*, **18**, 163–76 (*March*, 1952).

The gas fractionizing in the wide tube, at the beginning of the constriction, was especially investigated and it was found that the stationary state was reached under certain conditions after only several hours. This can cause rather big drift effects in the ratios of the gas components observed. The practical limitations to high precision mass-spectrometry were considered as far as the fractionizing in the gas sample itself changes the original composition. To reach an accuracy of 0·01% it is always advisable to make the container not smaller than 100 cm³. If also the pressure is kept sufficiently equal in various samples isotope ratio determinations of 0·01% in $O^{16} - O^{18}$ seem to be possible. This confirms the results of Urey *et al.* A.

533.17 : 541.24

4171. Molecular weight determinations by effusiometry. P. D. ZEMANY. *Rev. Sci. Instrum.*, **23**, 176–7 (*April*, 1952).

An effusiometer using a thermistor as a pressure gauge is described. Molecular weights can be determined with it with an average error of ±2%. Only a few hundredths of a cubic centimetre of gas at N.T.P. is required as a sample, and may be recovered. A.

533.21

4172. Isotherms of carbon monoxide between 0°C and 150°C and at pressures up to 3000 atmospheres. A. MICHELS, J. M. LUPTON, T. WASSENAAR AND W. DE GRAAFF. *Physica*, **18**, 121–7 (*Feb.*, 1952).

533.21 : 536.7

4173. Isotherms and thermodynamic functions of methyl fluoride at temperatures between 0°C and 150°C and at pressures up to 150 atmospheres. A. MICHELS, A. VISSER, R. J. LUNBECK AND G. J. WOLKERS. *Physica*, **18**, 114–20 (*Feb.*, 1952).

533.5

4174. A new method of trapping oil vapour. C. HAYASHI. Note in *J. Phys. Soc. Japan*, **6**, 413–14 (*Sept.–Oct.*, 1951).

Condensation of oil vapour in diffusion pumps in a layer of oil of low vapour pressure rather than on a cold surface is suggested. G. WITTENBERG

533.5

4175. Use of phosphorous pentoxide as a dehydrating agent in high vacuum technique. C. HAYASHI. Note in *J. Phys. Soc. Japan*, **6**, 414–15 (*Sept.–Oct.*, 1951).

Phosphorus pentoxide is used to remove water vapour at pressures of 10^{-3} to 10^{-5} mm Hg, the equilibrium pressure of phosphorus pentoxide being estimated at 10^{-6} mm Hg. Its efficiency decreases with increasing size of pump. G. WITTENBERG

533.5

4176. Some considerations on the design of the re-entrant tube vapour trap. D. W. STOPS. *J. Sci. Instrum.*, **29**, 121–5 (*April*, 1952).

Relations are developed giving the optimum dimensions for the re-entrant tube type of trap to ensure maximum conductance and minimum thermomolecular pressure effects. A.

533.6.011

4177. The unsteady subsonic motion of a sphere in a compressible inviscid fluid. A. L. LONGHORN. *Quart. J. Mech. Appl. Math.*, **5**, 64–81 (*March*, 1952).

An investigation of the effect of compressibility on

the work required to accelerate a rigid sphere, immersed in a fluid, from rest to a final uniform velocity. Viscosity is neglected, but it is shown that at the accelerations for which compressibility is important, the additional work (used in sending out sound waves) is all done before the boundary layer separates from the rear of the sphere. The work done on the fluid is increased twofold as a result of compressibility in the limiting case of infinite acceleration, but by a smaller factor for finite acceleration. The results apply when the Mach number is low. A.

533.6.011

4178. Interferometric analysis of airflow about projectiles in free flight. F. D. Bennett, W. C. Carter and V. E. Bergdolt. *J. Appl. Phys.*, **23**, 453–69 (*April*, 1952).

A description is given of the adaptation to the ENIAC of the interferogram reduction problem for axisymmetric flows. Isopycnal charts from interferograms of projectiles in free flight are presented, and comparison is made with similar studies by other workers using fixed models in a wind tunnel or a circular jet. In general, good agreement is found between density fields obtained by the two methods. Sources of error are discussed; and in particular, it is found that random errors accumulate to effect adversely the density values near the axis of the flow. A.

533.6.011.4

4179. Separation of the boundary layer at a slightly blunt leading edge in supersonic flow. O. Bardsley and W. A. Mair. *Phil. Mag.*, **43**, 344–52 (*March*, 1952).

Schlieren photographs have been taken to show the supersonic flow past a two-dimensional wedge placed at an incidence large enough to give an expansion region on one side. The leading edge was blunt in all cases, and its thickness t was varied between 35 and 200 microns. For values of t greater than about 80 microns the photographs showed a weak shock wave on the downstream side of the expansion region. A shock wave in this position indicates that there is a separation of the boundary layer near the leading edge, followed by re-attachment. The Reynolds number was about $1{\cdot}3\times10^5$ per cm, giving a value of about 1000 for $t = 80$ microns. It is concluded that separation of the boundary layer occurs when the Reynolds number, based on the thickness of the leading edge, is greater than about 1000. For smaller Reynolds numbers there was no evidence of separation. A.

533.6.08

4180. Determination of air velocity by ion transit-time measurements. W. C. Cooley and H. G. Stever. *Rev. Sci. Instrum.*, **23**, 151–4 (*April*, 1952).

A method is described for measuring the velocity of an air stream by producing positive ions at one point in the flow and measuring the time required for the ions to be carried to an induction-type detector located a known distance (0·5 to 2·0 in) downstream. Positive ions are produced intermittently near the tip of a positive corona point by burst discharges which are initiated by stray ions in the air stream or by irradiating the air in the neighbourhood of the positive corona point with Po α-particles. The ion transit-time is measured by observing the induced pulses from the detector on a cathode-ray oscillograph sweep which is triggered by the burst discharges of the corona point. The accuracy of velocity measurement using a measuring length of 1 in with a free-stream air velocity of 1730 ft/sec (based on pressure and temperature measurements) was better than 2%. It is shown that the direction of streamlines in a supersonic flow can be determined approximately by aligning the corona point and the induction detector probe to give the maximum amplitude of induced pulses. It is believed that this method may be applied to map velocity fields in supersonic wind tunnel experiments. A.

MOLECULAR THEORY OF GASES 533.7

533.7

4181. On a treatment of imperfect gases after Fermi's model. IV. M. Dutta. *Proc. Nat. Inst. Sci. India*, **17**, 445–66 (*Nov.–Dec.*, 1951).

In this paper, a new statistical theory of imperfect gases, developed in three previous papers [for Pt III, see Abstr. 7567 (1951)], is naturally extended with suitable modifications to a mixture of imperfect gases. For simplicity, the mixture of gases is taken to have only two components. Two quantities b_1 and b_2 are supposed to denote respectively two rigid volumes of exclusion of molecules of the two types for molecules of the same type, and in considering distribution of molecules of type (1), the available configurational space is divided into cells of volume b_1, and similarly, for molecules of type (2), into cells of volume b_2. Another quantity b_{12} is introduced to denote the volume of exclusion of molecules of one type for molecules of the other type. The effect of the finite size of molecules is considered by help of a principle of exclusion, analogous to that of Fermi. For the effect of cohesion, the configuration space is divided into two layers, one interior, of volume v_1, and the other a surface layer of volume v_2. The distribution in configurational space is calculated after Fermi, and that in momenta space after Planck and Lorentz. In this way, the equation of state, yielding van der Waals' equation for mixture of gases, has been obtained. Also on extending the method to the field of forces as described in Pt III, the form of Dieterici's equation for mixture of gases has been worked out. A.

VIBRATIONS . ACOUSTICS 534

534.1

4182. On the proof of some uniqueness theorems occurring in the theory of steady vibrations. I. N. Vekua. *Dokl. Akad. Nauk SSSR*, **80**, 341–3 (*No.* 3, 1951) *In Russian.*

The author's proof of uniqueness theorems for boundary electromagnetic wave problems [*Trudy Tbilissk. Matem. Inst.*, **12** (1943)] is extended to the

solution of elastic vibration problems. Kupradze's concept of quasi-energy [*Boundary problems of the vibration theory and integral equations* (1950) *In Russian*] only complicates the proof. A. GELBTUCH

534.113

4183. Analytical and numerical contributions to the study of vibrating rods. I. D. CALIGO. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **12,** 76–83 (*Jan.*, 1952) *In Italian.*

The equations of vibration are solved analytically and there is an asymptotic discussion. Numerical tables of certain integrals occurring in the theory of the free rod are given. L. S. GODDARD

534.22

4184. On the velocity of sound in pentane and isopentane in the critical region. R. KLING, E. NICOLINI AND J. TISSOT. *C.R. Acad. Sci.* [*Paris*] **234,** 708–10 (*Feb.* 11, 1952) *In French.*

The ultrasonic diffraction method is used to give results as a function of temperature and pressure. Earlier results have been confirmed. G. F. HODSMAN

534.222.2

4185. Shock wave formation in a shock tube. G. A. LUNDQUIST. Letter in *J. Appl. Phys.*, **23,** 374–5 (*March*, 1952).

After a brief review of recent work relating to shock waves generated in shock tubes, comprising two sections, in which a high and a low pressure, respectively, are maintained, and which are separated by a diaphragm, it is remarked that Lukasiewicz has suggested that deviations of measured shock speeds from theoretically predicted values may be due to taking measurements too close to the diaphragm. It has now been found that, using a 20×20 cm shock tube with air at 24°C in both chambers, and diaphragm pressure ratios up to 10 000, shock velocities measured close to the diaphragm are consistently less than those measured at some distance away. At a distance of about 5 m from the diaphragm shock waves for all diaphragm pressure ratios, up to 10 000, reach a max. value equal to that predicted by theory.

J. S. G. THOMAS

534.23

4186. Dispersion and absorption of sound in gases in general chemical equilibrium. D. TABUCHI. *Mem. Res. Inst. Acoust. Sci. Osaka*, **2,** 50–60 (*March*, 1951).

Gases are considered theoretically which are in general chemical equilibrium, dissociation being included as a special case. It is assumed that the gas is ideal, the absorption of sound due to viscosity, thermal conduction and radiation is negligible, and that the transition between the translational and internal energies of the molecules occurs at infinite speed, i.e. the specific heat of the gas is not dependent on the sound frequency. Equations are deduced for the velocity of sound and the absorption coefficient of the gas, and then the complex sound velocity is deduced from the acoustic characteristic equation. The theoretical values obtained by Einstein and Luck for dissociating gases are found in good agreement with those deduced in the present paper.

A. C. WHIFFIN

534.23

4187. Nonlinear absorption and dispersion of plane ultrasonic waves in pure fluids. C. TRUESDELL. *J. Wash. Acad. Sci.*, **42,** 33–6 (*Feb.*, 1952).

In a preliminary discussion on absorption in fluids it is pointed out that the mean free path argument of previous workers cannot be applied to liquids. While the 2 term power series expansion for the absorption and dispersion coefficients is not accurate the exact solution of the Navier–Stokes equations fits experiment very well. T. C. TOYE

534.23 : 532.782

4188. Ultrasonic absorption in supercooled liquids. A. N. HUNTER. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **64,** 1086–7 (*Dec.*, 1951).

The absorption and wavelength of ultrasound was determined in menthol using the pulse technique at a test frequency of 68 Mc/s over the temperature range 32–80°C, while salol and di-phenyl ether were tested over the range 10–90°C. All three liquids show a marked increase of absorption near the freezing point. It was thought that the increase might be due to scattering at crystal nuclei. Experiments with menthol at 87·5 Mc/s showed that at all temperatures the absorptions at the two test frequencies were in the ratio 1·65, indicating a square law, whereas scattering should give 2·72 in accordance with a fourth power law. A. C. WHIFFIN

534.231

4189. The sound field from a pulsating sphere and the development of a tail in pulse propagation. C. BARNES AND D. V. ANDERSON. Letter in *J. Acoust. Soc. Amer.*, **24,** 229 (*March*, 1952).

The paper gives a simple form of solution for radial vibrations of a general kind. The solution is particularly well adapted to the investigation of the propagation of a pulse. The paper concludes with a discussion of the formation of a tail to a pulse in the cases of one and three-dimensional propagation and of plane and spherical waves. A. B. WOOD

534.231

4190. A new expansion for the velocity potential of a piston source. A. H. CARTER AND A. O. WILLIAMS, JR. *J. Acoust. Soc. Amer.*, **24,** 230 (*March*, 1952).

The note refers to an incorrect statement of the convergence condition in a paper [Abstr. 5194 (1951)] and gives the modification required in the paraxial expansion. A. B. WOOD

534.24

4191. The directional characteristics of conical reflectors. R. TAKEUCHI. *Mem. Res. Inst. Acoust. Soc. Osaka*, **1,** 33–7 (*Feb.*, 1950).

The directional properties of a ringstack projector mounted coaxially with a conical reflector are calculated in terms of a convergent series on the assumption that the whole surface of the ringstack vibrates with the same amplitude and phase. G. L. WILSON

534.26 : 538.566

4192. Multiple scattering of radiation by an arbitrary planar configuration of parallel cylinders and by two parallel cylinders. V. TWERSKY. *J. Appl. Phys.*, **23,** 407–14 (*April*, 1952).

The formal solution for the scattering of a plane wave by an arbitrary configuration of parallel cylinders

previously presented [Abstr. 2544 (1952)] is specialized to consider the case where all the axes lie in the same plane. The scattered wave is expressed as an infinite sum of orders of scattering, the first order being the usual single scattering approximation. It is shown that the far field form of the multiply scattered orders is symmetrical with respect to the plane of the configuration for minimum spacing large compared to wavelength. Hence, for the analogous configuration of bosses on a perfectly conducting plane, departures from the predictions of single scattering theory should occur primarily for the component polarized perpendicular to the elements. The problem of two cylinders is considered in detail, the multiply scattered orders being summed explicitly subject to the above conditions. Approximate solutions for radii very small compared to wavelength are derived, the wavelengths for which the effects of multiple scattering are greatest are investigated, and a criterion for the use of the single scattering hypothesis presented. Solutions for two bosses and a single cylinder parallel to a non-absorbing plane are also stated. Both the electromagnetic and acoustic cases are treated. A.

534.321.3

4193. Geometrical representation of the spectra of musical scales. F. FRAUNBERGER. *Naturwissenschaften*, **39**, 83–4 (*No.* 4, 1952) *In German.*

Reference is made to a paper by H. Grunacher [*Naturwissenschaften*, **21**, 824 (1933)] which gives an expression relating the musical interval values to a series of numbers (Laufzahlen) $n = 2, 3, 4, 8$ and ∞. The present paper discusses the significance of this expression and shows the various musical scales can be represented geometrically. A. B. WOOD

534.414

4194. Helmholtz resonator with a small cavity. J. MERHAUT. *Slabopr. Obz.*, **12**, 235–7 (*No.* 10, 1951) *In Czech.*

The classical equation is valid only for Helmholtz resonators in which the cavity volume is sufficiently large relative to the dimensions inlet tube. In electro-acoustic apparatus the resonator volume is frequently so small that the system approaches the shape of a closed pipe. To simplify the solution of problems relating to such acoustic circuits, a generally valid formula is derived by means of the waveguide theory which is applicable to any ratio of cavity volume to inlet cross-section. In extreme cases the general formula becomes identical respectively with the Helmholtz formula and the formula applicable for closed pipes. A nomogram enabling simple solution of cases which may occur in practical work is given.

E. GROS

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 4832–5

534.771 : 612.85

4195. Audiometric measurement of hearing loss. F. J. MEISTER. *Arch. tech. Messen, Issue* 192 (*Ref. V* 666–1) 15–18 (*Jan.*, 1952) *In German.*

After a general discussion of the methods of testing hearing and the basis of measuring techniques, a description is given of two forms of audiometers used in the measurement of hearing loss over a range of frequencies 64 c/s to 12 kc/s. A. B. WOOD

534.773.2 : 621.395.2

4196. The Medresco hearing aid. C. J. CAMERON AND E. W. AYERS. *P.O. Elect. Engrs' J.*, **44**, 153–8 (*Jan.*, 1952).

An account of the Medical Research Council's hearing aid as developed by the G.P.O. Following a brief review of hearing defects and desirable characteristics of hearing aids, a description of the Medresco IIA aid is given, together with details of the components used. Reference is also made to possible future trends in hearing aid design.

G. F. HODSMAN (R)

534.833

4197. Effect of factory room acoustical material installation. G. L. BONVALLET. Letter in *J. Acoust. Soc. Amer.*, **24**, 229–30 (*March*, 1952).

Results are given showing the reduction in sound level obtained in a factory room 100 ft × 100 ft × 20 ft by the use of acoustic material on the ceiling.

G. F. HODSMAN

534.843

4198. The acoustics of rooms from the point of view of the singer and the orator. R. HUSSON, E. J. GARDE AND A. RICHARD. *Ann. Télécommun.*, **7**, 58–74 (*Feb.*, 1952) *In French.*

The requirements are shown to be not necessarily those which give the best acoustic properties for the listener. Consideration is given to the reasons why singers and orators quickly become fatigued in certain rooms. The physiological mechanisms involved in voice production are discussed in detail and it is shown that an analysis of the local energy conditions in the immediate vicinity of the subject is essential. A reconciliation of the acoustic requirements of rooms for both voice production and audition is discussed. An extensive bibliography is appended.

G. F. HODSMAN

534.846.4 : 621.395.623.8

4199. Sound reinforcement and production for Royal Festival Hall. J. L. GOODWIN. *Elect. Commun.*, **28**, 243–50 (*Dec.*, 1951).

The construction of the hall and the considerations governing the positioning and arrangement of the loudspeakers for bin-aural reinforcement is described and illustrated by a photograph of the interior and a cross-section of the elevation. The sound control operator sits in a small cubicle half-way up one side of the auditorium so that the results can be heard directly. The cubicle shape demanded a special design of control console which is illustrated together with a block schematic of all the control equipment. About 15% of the seats are fitted with deaf aid. An additional announcing system is provided which can also accept signals from two gramophone pick-ups. A feature is a special 440 c/s gong the vibrations of which are picked up electro-magnetically and reproduced over the system to warn the audience at the end of an interval. See also following abstract.

B. B. AUSTIN (R)

534.846.4 : 621.395.623.8

4200. Speech reinforcement in St. Paul's Cathedral. P. H. PARKIN AND J. H. TAYLOR. *Wireless World*, **58**, 54–7 (*Feb.*); 109–11 (*March*, 1952). Brief report also in *Nature* [*Lond.*] **169**, 214–15 (*Feb.* 9, 1952).

The large reverberation time, up to 12 sec empty

and 8 sec full of St. Paul's plus the lack of absorptive material make speech very difficult. Frequency limitation in several other buildings is discussed and a suitable speech range arrived at for St. Paul's. For intelligible speech, the intensity of the direct speech must always be greater than that of the reflected. Formulae are given showing the energy of direct and reflected waves. It is shown that under certain conditions the distance covered before direct and reflected powers are equal is 9 times greater with a directional than with a point source. For St. Paul's a "line" source of 11 l.f. speakers and 9 h.f. were arranged in a vertical column which produced a fan-shaped horizontal polar diagram, but an exceedingly narrow vertical one to prevent reflection from the upper part of the building. To give the effect of all the sound coming from the pulpit the sound is recorded on a disk with variable position playback heads placed to give a delay up to 15 msec for some speaker columns. Erasure of the recording takes place after each revolution. A table of speech intelligibility with and without delay is given. See also preceding abstract. B. B. AUSTIN (R)

534.861.1

4201. Orchestral studio design. T. SOMERVILLE AND H. R. HUMPHREYS. *Wireless World*, **58**, 128–31 (*April*, 1952).

An account of modifications made to the B.B.C. Maida Vale studio, which have greatly reduced boominess and cured the deadness at high frequencies. The chief measures taken consist in the fitting to the walls of rectangular absorption units resonant at 62, 80, 250 or 300 c/s, and of large box-like devices to the ceiling. Specially upholstered choir seats have been added and changes have been made to the floor covering and orchestra rostrum. W. G. STRIPP

534.88

4202. A small echo depth sounder for shallow water. K. UETSUKI AND K. KATO. *Mem. Res. Inst. Acoust. Sci. Osaka*, **1**, 20–7 (*Feb.*, 1950).

Separate nickel magnetostriction ringstacks, resonant at 50 kc/s, mounted in conical reflectors, are used as projector and receiver. The indicating unit consists of a rotating table carrying a neon lamp and a contact which discharges a condenser through the projector, producing a damped wave train. The direct signal and the echo, after amplification, actuate a trigger circuit which lights the neon lamp, and the angular separation of the two flashes gives the depth on a calibrated scale. A range of 200 m is claimed. G. L. WILSON

OPTICS . RADIATION . SPECTRA 535

535.1

4203. The optical theory of Willard Gibbs. L. P. WHEELER. *Proc. Nat. Acad. Sci.* [*Wash.*] **37**, 850–5 (*Dec.*, 1951).

The problem of electromagnetic propagation through matter, both transparent and absorbent, was formulated by Gibbs in a simple and general manner, which is here compared with other treatments. It is suggested that the Gibbs treatment, which has been neglected, deserves further study.

P. M. DAVIDSON

535.23

4204. An undergraduate course in radiation physics. C. M. ZIEMAN. *Amer. J. Phys.*, **20**, 213–17 (*April*, 1952).

A course is described dealing with the basic phenomena of radiation. Knowledge of differential equations is prerequisite. Since no appropriate textbook is available, more than thirty textbooks are mentioned from which a student may draw his material. Laboratory experiments are an important part of the course. Sources of material for these experiments are quoted. A.

535.237 : 548.0

The relation between thermo-optic and piezo-optic phenomena in crystals. *See Abstr.* 4278

535.247.4

4205. A physical comparator for the color temperatures of incandescent lamps. E. J. KING, A. E. SNIDER AND F. HAMBURGER, JR. *J. Opt. Soc. Amer.*, **42**, 178–81 (*March*, 1952).

A red-to-violet ratio method of establishing the effective slope of the radiometric function is utilized. The apparatus uses a single 931-A photomultiplier to receive radiations from the "standard" and "unknown" lamps through red and violet filters sequentially. Resultant oscilloscope patterns are judged for equality. Accurate results can be obtained in a short period of time, thus permitting large quantities of lamps to be calibrated with a minimum of effort. A.

535.247.4

4206. An improved recording microphotometer. L. LUNDIN. *Ark. Fys.*, **4**, 391–8 (*Paper* 21, 1952).

The instrument produces automatic recordings from spectral plates. A mechanical wedge system transfers distances on the plate to the recording paper with an error of $< 1\ \mu$ in the plate scale, and a magnification variable between 3 and 200. The plate is scanned by a slit of adjustable width and length, and the transmitted light detected by an R.C.A. 931A photomultiplier. Diagrams and photographs are given, and the resolving power illustrated by reproductions of records made with the instrument.

S. T. HENDERSON

535.31

4207. The boundary of total reflection. I. The ray approximation with the Wolter ray definition. H. MAECKER. *Ann. Phys.* [*Lpz.*] **10**, 115–28 (*No.* 1–2, 1952) *In German.*

Wolter defines a ray as the intersection point of two slightly inclined wavefronts. This definition is applied to the case of total reflection at the critical angle and the well-known displacement of the ray can be calculated. The totally reflected wavefront is shown to divide into two parts, one spherical in form, the other conical. The totally reflected rays form a caustic which is the true boundary between the partially and totally reflected light. Numerical values are given for the intensity distribution in the reflected virtual image of a point source. Wave

optics are necessary to give a second approximation to this distribution. R. W. FISH

535.315

4208. Note on "A new constant-deviation prism arrangement". W. WEINSTEIN. Letter in *J. Opt. Soc. Amer.*, **42**, 142–3 (*Feb.*, 1952).

The claim for increased resolving power with the constant-deviation prism arrangement of Abstr. 4226 (1951) is shown to be invalid. Moreover the collimator and telescope optics must have larger diameters and the slit must be finer than in alternative arrangements having the same energy and spectral purity. R. W. FISH

535.315

4209. Note on "A new constant-deviation prism arrangement". S. MAKISHIMA, Z. KOANA AND K. OSHIMA. Letter in *J. Opt. Soc. Amer.*, **42**, 143 (*Feb.*, 1952).

The criticism (preceding abstract) of the claim for increased resolving power is accepted. The authors point out that the system is not identical with the Young–Thollon type as the latter does not always satisfy the condition of minimum deviation. R. W. FISH

535.315 : 535.515

4210. A modification of the Fresnel rhomb. F. MOONEY. *J. Opt. Soc. Amer.*, **42**, 181–2 (*March*, 1952).

A rhomb consisting of two dense flint equilateral prisms may be used to deviate light and introduce polarization effects analogous to those of the Fresnel rhomb which displaces light. Because of the high index of the prism material ($\mu_D = 1{\cdot}650$), the wavelength response of the prism rhomb is superior to that of the classical low index Fresnel rhomb. Perpendicular transit of glass surfaces and invariance of the direction of the emergent light apply for both types, but in other respects the rhombs are complementary. In addition, the necessary prisms are widely available commercially. A.

535.317.2

4211. The attainment of a given image magnification during the correction of an optical system by "bending" any desired surface. A. THOMESCHEIT. *Optik*, **9**, 43–4 (*No.* 1, 1952) *In German.*

The method given by Roll ensures that the focal length of the lens system can be kept constant after the "bending" of a component. The present note discusses the changes necessary in the procedure to ensure that the magnification of an object remains constant during this operation. R. W. FISH

535.317.5

4212. Aberrations of the image in Cartesian lens systems. D. MAEDER. *Optik*, **9**, 49–74 (*No.* 2, 1952) *In German.*

The image formation is investigated for lenses whose surfaces are Cartesian ovals and therefore free from spherical aberration. Methods of computation for axial and extra-axial rays are given and the aberrational coefficients are derived in the form of matrix products. The performance of single lenses and symmetrical doublets is discussed in detail. An $f/1{\cdot}25$ system for photography of C.R.T. traces is described. 18 refs. R. W. FISH

535.317.9

4213. Analytical calculation of the refraction across a quadric of revolution. J. PELTIER. *Rev. Opt.* (*Théor. Instrum.*) **31**, 131–5 (*March*, 1952) *In French.*

The establishment of the most general ray tracing formulae for calculating the refraction of a ray as a second degree surface of revolution. The solution aims at the adaptation of the final formulae to automatic calculators. A.

535.317.9

4214. Ray tracing through uncentered and aspheric surfaces. W. A. ALLEN AND J. R. SNYDER. *J. Opt. Soc. Amer.*, **42**, 243–8 (*April*, 1952).

Generalized ray tracing equations are derived to include special cases in optics such as uncentred spherical interfaces, prisms, mirrors and centred aspheric surfaces. These equations were constructed for use with the IBM Card Programmed Electronic Calculator. The method has been applied to complicated optical systems involving uncentred lenses in addition to reflecting and refracting prisms. A method is given for the design of an aspheric surface, and a design curve of an aspheric optical system is given as an example. A.

535.323 : 535.341

4215. The optical constants of lead sulphide and lead telluride in the region 0·5–3 microns. D. G. AVERY. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 1087–8 (*Dec.*, 1951).

Values of refractive index and absorption constant, determined from reflection intensities in two planes of polarization, are plotted graphically. G. F. LOTHIAN

535.33.03 : 537.542

4216. A new type of hydrogen discharge tube. G. H. DIEKE AND S. P. CUNNINGHAM. *J. Opt. Soc. Amer.*, **42**, 187–9 (*March*, 1952).

Details are given for an electrodeless hydrogen discharge tube excited in a microwave cavity. The tube is extremely simple in construction. The hydrogen is stored as UH_3. The excitation is efficient, and the spectrum is obtained with great strength and purity. Discharge conditions can be held constant much better than in the conventional tubes. A.

535.33.03

4217. Radiant energy in different wavelength regions for condensed discharges in krypton. Comparison with results for xenon. R. LEGROS. *C.R. Acad. Sci.* [*Paris*] **234**, 1047–8 (*March* 3, 1952) *In French.*

With some exceptions the results for discharges in krypton are similar to those given for xenon previously [Abstr. 3431 (1952)] but the total intensity of the emission from xenon is 1·25 to 2·1 times that from krypton for the same conditions. G. F. J. GARLICK

535.33.03

4218. Spectroscopic intensity modulation. E. HULTHÉN. *Ark. Fys.*, **4**, 399–406 (*Paper* 23, 1952).

The term intensity modulation refers to the periodicity that appears in the spectrum when the spectroscopic beam of rays is divided into interfering parts. It allows the presence of individual components

in an unresolved group of lines to be revealed with precision. Experimental methods using a grating interferometer are described and some results of an examination of the line Hg 5461 are given. R. W. FISH

535.33.03–15

4219. Notes on the practice of infrared spectroscopy. R. C. LORD, R. S. MCDONALD AND F. A. MILLER. *J. Opt. Soc. Amer.*, **42**, 149–59 (*March*, 1952).

Miscellaneous techniques for infrared prism spectroscopy are described in detail. These include: techniques for cleaving, cutting and polishing alkali halide crystals for absorption cell windows; construction of absorption cells for liquids and gases, including some suitable for high and low temperatures and one of long path; the measurement of cell thickness; removal of atmospheric absorption; techniques useful for wavelengths above 25 microns; formulae for recording inks. A modified source-optical system and a method of calibration adjustment for Perkin–Elmer Model 12 instruments are also discussed. A.

535.33.07

4220. Use of a photomultiplier to measure intensities in the vacuum ultra-violet region. J. H. BOLTON AND S. E. WILLIAMS. Letter in *Nature* [*Lond.*] **169**, 325–6 (*Feb.* 23, 1952).

An R.C.A. photomultiplier E.M.I. type 5060 with fluorescent Apiezon B or L on the window to act as a frequency convertor is shown to be an efficient detector out to 970 Å. A H lamp spectrum near 1215 Å with a 14 400 lines/in grating is shown, and atomic and molecular lines distinguished from the intensity–pressure dependence. D. H. WHIFFEN

535.33.07–14

4221. A Zeeman modulation microwave spectrograph of high sensitivity. K. SHIMODA AND T. NISHIKAWA. *J. Phys. Soc. Japan*, **6**, 516–20 (*Nov.–Dec.*, 1951).

A low frequency Zeeman modulation microwave spectrograph for observing hyperfine structure of atomic sodium has been constructed. Its experimental details and the principle of operation are given. The sensitivity of the spectrograph may be estimated like that of the Stark modulation spectrograph. Since the modulation frequency cannot be chosen so high as Stark modulation, the noise figure of the crystal detector is rather large, which might be overcome if the source modulation were superposed. A.

535.33.07–15

4222. Infra-red spectrometer with cathode ray presentation. H. POWELL. *Appl. Spectroscopy*, **6**, 3–7 (*Feb.*, 1952).

535.33.07–15

4223. Substitution of a fast thermocouple for a bolometer in an infra-red spectrometer. A. R. ROBERTS. *J. Sci. Instrum.*, **29**, 134 (*April*, 1952).

535.337 : 537.52

4224. Excitation of high rotational levels in the first positive system, $B^3\Pi_g$–$A^3\Sigma_u$, of N_2. R. HERMAN AND C. WENIGER. *C.R. Acad. Sci.* [*Paris*] **234**, 928–30 (*Feb.* 25, 1952) *In French.*

535.338

4225. Interpretation of the multiplet spectra of organic molecules. S. NIKITINE. *C.R. Acad. Sci.* [*Paris*] **234**, 926–8 (*Feb.* 25, 1952) *In French.*

An application of the metallic model to the π-electron systems of thionine, methylene blue, napthalene and anthracene. H. H. GREENWOOD

535.338.32

4226. Isotope effect in the imprisonment of resonance radiation. T. HOLSTEIN, D. ALPERT AND A. O. MCCOUBREY. *Phys. Rev.*, **85**, 985–92 (*March* 15, 1952).

On theoretical grounds it is expected that the decay time of imprisoned resonance radiation in the vapour of a single even isotope of mercury should be some six times larger than that observed with the natural samples of mixed isotopic constitution. To investigate this effect experimentally, decay measurements were carried out with samples of Hg^{198} (3% Hg^{199} and 0·1% Hg^{200}). For vapour densities $N \gtrsim 10^{14}/cm^3$, the predicted effect was verified. For $N > 10^{14}/cm^3$, the observed decay time drops below that predicted theoretically for pure Hg^{198}. This secondary effect is here attributed to the transfer of excitation from Hg^{198} to Hg^{199} and Hg^{200} by collisions of the second kind. Comparison of experimental data with an appropriately generalized theory permits estimation of the cross-section for such collisions. The value so obtained is 10^{-13} cm^2, some twenty times the gas-kinetic cross-section, and in order-of-magnitude agreement with theoretical expectations. A.

535.338.4

4227. On the band-system of neutral OD. H. OURA. Note in *J. Phys. Soc. Japan*, **6**, 401–2 (*Sept.–Oct.*, 1951).

The results of rotational analysis of the 1, 0, 2, 1, 1, 1, 2, 2, 0, 1 and 1, 2 bands of the system $A^2\Sigma^+$–$X^2\Pi_i$ are reported [for the 0, 0 band, see H. Oura and M. Nimomiya, *Proc. Phys. Math. Soc. Japan*, **25**, 335 (1943)]. The following constants are derived: $B''_v = 9{\cdot}991 - 0{\cdot}258\ (v'' + \frac{1}{2})$; $B'_v = 9{\cdot}043 - 0{\cdot}331\ (v' + \frac{1}{2})$. $\omega''_e = 2716{\cdot}13$, $x''_e\omega''_e = 42{\cdot}15$; $\omega'_e = 2313{\cdot}5$, $x'_e\omega'_e = 49{\cdot}18$. The origin of the 0, 0 band is at 32 477·4 cm^{-1}. The wave-numbers of the band-lines are given in *Low Temperature Science*, **6**, 41–70 (1951) [in Japanese]. R. F. BARROW

535.338.4

4228. $^5\Pi - {}^5\Sigma$ electronic transition in cobalt chloride. V. G. KRISHNAMURTY. Letter in *Curr. Sci.*, **20**, 323 (*Dec.*, 1951).

The vibrational analysis of a system with 0, 0 sequence at 5650–5770 Å is briefly reported. R. F. BARROW

535.338.4

4229. Transition probabilities for C_2 and N_2^+. H. SHULL. Note in *Astrophys. J.*, **114**, 546 (*Nov.*, 1951).

See Abstr. 185 (1951). The calculations have been repeated with the dipole-velocity form of the transition operator but with the same approximate methods and orbitals as before. The net effect of the results is to reduce considerably the estimates of C_2 (and possibly CN) concentrations wherever these are

based upon absolute intensity measurements of these transitions. A.

535.338.4

4230. Transition probabilities of some band systems of nitrogen. D. D. Desai, K. S. Korgaokar and B. B. Laud. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 228–30 (*March*, 1952).

Published values of vibrational transition probabilities are compared for the Second Positive System. There is good agreement between experimental values of Tawde and Patankar and calculations by Bates and by Nicholls. A. G. GAYDON

535.338.4

4231. Emission spectrum of acetaldehyde. S. Régnier. *C.R. Acad. Sci.* [*Paris*] **234**, 930–1 (*Feb.* 25, 1952) *In French.*

The mode of decomposition of acetaldehyde by a high-frequency electric discharge is investigated by photographing its emission spectrum using a Hilger spectrograph. Exptl. details and a brief discussion of the results obtained are given. G. I. W. LLEWELYN

535.338.4

4232. The spectrum of lutecium monoxide. A. Gatterer and S. G. Krishnamurty. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 151–2 (*Feb.*, 1952).

The spectrum of LuO is well developed in the flame of a heavy-current arc. Vibrational analyses of the α- and γ-bands are given. The β- and γ-bands appear to arise from a transition $C^2\Pi - X^2\Sigma$, with a doublet interval of 2114 cm^{-1}. The α-system may be $^2\Sigma - {}^2\Sigma$. R. F. BARROW

535.338.4

4233. Two band systems of tungsten oxide. A. Gatterer and S. G. Krishnamurty. Letter in *Nature* [*Lond.*] **169**, 543 (*March* 29, 1952).

Gives details of two band systems observed with high temp. d.c. arcs between W-electrodes. J. D. CRAGGS

535.338.4 : 535.343

4234. The spectrum of NS. R. F. Barrow, A. R. Downie and R. K. Laird. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 70–1 (*Jan.*, 1952).

New observations on the γ-system, $^2\Sigma \rightleftarrows {}^2\Pi$, are reported [see also Abstr. 7684 (1951)]. A preliminary analysis of the β-system suggests that it may be $^2\Delta - {}^2\Pi$, with $B'_v = 0{\cdot}694_5 - 0{\cdot}005_4\,(v' + \frac{1}{2})$.

R. F. BARROW

535.338.4 : 537.525 : 551.594.5

4235. Meinel's infra-red auroral bands. N. D. Sayers. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 152–3 (*Feb.*, 1952).

Laboratory production of the bands in electron-beam and hollow-cathode sources is described [see also Abstr. 879 (1952)]. R. F. BARROW

535.338.4 : 539.155.2

4236. Band spectra in the Schumann region of NO and N_2^+ with enriched nitrogen-15. P. Baer and E. Miescher. Letter in *Nature* [*Lond.*] **169**, 581 (*April* 5, 1952).

Measurement of the vibrational isotope effect leads to the following conclusions: (1) the ε-bands of NO belong to a separate system, and do not form a continuation of the γ-system [Herzberg and Mundie, *J. Chem. Phys.*, **8**, 263 (1940)]; the vibrational analysis of the β'-bands of NO [Baer and Miescher, Abstr. 3447 (1952)] is confirmed; (3) the vibrational analysis of the $C - X$ system of N_2^+ proposed by Setlow [Abstr. 2894 (1948)] is confirmed. A new system with $\nu_{0,0} = 73\,087$, $\Delta G'_{0,1} = 1560$ cm^{-1} and having as its lower state either $X'\Sigma$ of N_2 or $A^2\Sigma$ of NO has been discovered. R. F. BARROW

535.339

4237. Double monochromator optical system based upon ideas of Czerny and Turner. V. Roberts. Letter in *J. Sci. Instrum.*, **29**, 134–5 (*April*, 1952).

The instrument described was made in 1945. It may be regarded as two identical monochromators in series, and this arrangement gives a high freedom from scattered radiation, 1 part in 10^4 at 20 μ. A disadvantage of the instrument is the large number of reflecting surfaces. Sample records are shown.

R. W. FISH

535.341

4238. Cross section of the neon absorption continuum. Po Lee and G. L. Weissler. Letter in *J. Opt. Soc. Amer.*, **42**, 214–15 (*March*, 1952).

Experimentally determined absorption coeffs. for neon show a steep rise near the series limit at 5742 Å from zero to a max. of $k = 155$ cm^{-1}, in good agreement with the theoretical calculations of Bates and Seaton. D. L. EDWARDS

535.341–32

4239. Absorption coefficients of oxygen in the vacuum ultraviolet. G. L. Weissler and Po Lee. *J. Opt. Soc. Amer.*, **42**, 200–3 (*March*, 1952).

Absorption coefficients of O were measured between 300 Å and 1300 Å using a grazing incidence vacuum spectrograph together with a line emission light source. The coefficients near 1300 Å were less than $k = 10$ cm^{-1}. The bands in the region between 1300 Å and 1000 Å showed strong absorption of the same order of magnitude as in the Worley bands of N. No strong continuous absorption was found in the region between 1300 Å and 740 Å. The continuous absorption of O below 740 Å was interpreted as composed of the ionization continua of several Rydberg series converging to the excited states of the molecular ion of O. The continuum had a broad maximum with k-values of about 700 cm^{-1} between 400 Å and 600 Å and, in contrast to N, still showed a large absorption of $k = 530$ cm^{-1} at 303 Å. An estimate of the integrated absorption coefficient was made and the corresponding f-value was found to be 6, in agreement with the predictions from classical dispersion theory. A.

535.343 : 535.372 : 539.217

4240. Absorption and fluorescence of solid solutions MgO–NiO. F. A. Kröger, H. J. Vink and J. van den Boomgaard. *Physica*, **18**, 77–82 (*Feb.*, 1952).

The absorption spectrum of MgO–NiO solid solutions between 2500 and 8000 Å shows 5 discrete bands with maxima at 2900 Å, 4000 Å, 4650 Å, 6700 Å and 7200 Å. At liquid air temperature the 4000 Å and 4700 Å bands show a fine structure with $\Delta\nu = 235 - 240$ cm^{-1}. MgO containing 10^{-3} mol NiO shows a

green cathodo-luminescence at liquid air temperature in a band consisting of at least 8 equidistant sub-bands with a $\Delta\nu = 194\ cm^{-1}$. The bands are attributed to electronic transitions between various states of the Ni^{2+} ion broadened by coupling with vibrations. This explains why NiO irradiated with 2500 Å $< \lambda <$ 8000 Å does not show photoconductivity. A.

535.343–15

4241. Infrared absorption spectra of ions of the type BO_2^- and BO_2^{---}. C. DUVAL AND J. LECOMTE. *Bull. Soc. Chim. France*, **19**, 101–5 (*Jan.–Feb.*, 1952) *In French.*

The complex spectra cannot be explained by simple structures BO_2^- and BO_3^{---}. The formation of $(BO_2)_n$ and $(BO_3)_n$ is suggested, and the possible modes of vibration for $n = 2$ are studied. H. H. GREENWOOD

535.343–15

4242. An absorption band of NOCl at 30 μ. W. H. EBERHARDT AND T. G. BURKE. Letter in *J. Chem. Phys.*, **20**, 529–30 (*March*, 1952).

The absorption is measured from 1 to 40 μ. A band with origin 329 cm^{-1} is found for $NOCl^{35}$ and at 325 cm^{-1} for $NOCl^{37}$, the fine structure approaches that of a prolate symmetric top. The isotopic shift is calculated. C. TURNER

535.343-15 : 541.65

4243. Infrared spectra of eighteen halogen-substituted methanes. E. K. PLYLER AND W. S. BENEDICT. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 202–20 (*Sept.*, 1951).

In order to study how the vibrational frequencies of methane vary with halogen substitutions, the infrared spectra of halogen-substituted methanes have been studied with a prism spectrometer between 2 and 38 microns. Spectra are presented as obtained at room temperature in the vapour and liquid states, and in a few cases in solution. The bands are interpreted as fundamentals, overtones, combinations and difference bands. Tables and graphs display the regularities existing among the various fundamentals of these molecules and other halogen-substituted methanes. Force-constant calculations, using an approximate potential function with general constants transferred from one molecule to another are reported. A.

535.343–32 : 541.65

4244. Effects of substituents on ultra-violet absorption spectra. R. D. BROWN. Letter in *Nature* [*Lond.*] **169**, 286–7 (*Feb.* 16, 1952).

The effect of substituents in conjugated compounds on the ultraviolet absorption frequencies is considered. It is stated, both on experimental and theoretical grounds, that hypsochromic shifts are more frequent than is usually assumed. A. J. TAYLOR

535.343.4

4245. Effect of temperature on the absorption spectrum of gaseous nitrous oxide between 2100 and 1600 Å. J. ROMAND AND J. GRANIER-MAYENCE. *C.R. Acad. Sci.* [*Paris*] **234**, 824–6 (*Feb.* 18, 1952) *In French.*

Measurements of extinction coefficients at temperatures from 183° to 573°K are reported [see also Abstr. 866–7 (1950)]. R. F. BARROW

535.343.4 : 551.593.52

4246. Atmospheric transmission at high temperatures. J. H. TAYLOR, W. S. BENEDICT AND J. STRONG. Letter in *J. Chem. Phys.*, **20**, 528–9 (*March*, 1952).

Absorption spectra for atmospheric air at 500°C (3 m path, carbon arc source) show, when compared with air at 25°C, nearly 100 new temperature-dependent H_2O lines most of which have been identified as higher level transitions in the R_{11}, R_{21} and R_{31} series. F. LACHMAN

535.343.4–32

4247. Analysis of the near-ultraviolet absorption spectrum of *p*-cresol vapor [1], and the long wavelengths absorption bands of benzaldehyde, acetophenone, and benzophenone. S. IMANISHI, M. ITO, K. SEMBA AND T. ANNO. Letter in *J. Chem. Phys.*, **20**, 532–3 (*March*, 1952).

The band system of (1) at 2480–2945 Å is analysed and the vibration frequencies tabulated together with other published values. The other compounds are discussed more briefly. G. F. LOTHIAN

535.345

4248. Change with temperature of the transparency of quartz in the Schumann region. A. GILLES. *C.R. Acad. Sci.* [*Paris*] **234**, 822–4 (*Feb.* 18, 1952) *In French.*

Measurements between $\lambda = 1600$ and 2000 Å, and at temperatures between room temperature and 1000° of the extinction-coefficient of "homosil" (molten quartz) and crystalline quartz show a discontinuity for the crystalline between 500 and 600° (transition from α- to β-quartz) and a smooth curve for the homosil. At high temperatures the crystalline extinction approaches the homosil-curve. C. TURNER

535.345–15

4249. Filters for the infrared region. E. K. PLYLER AND J. J. BALL. *J. Opt. Soc. Amer.*, **42**, 266–8 (*April*, 1952).

The infrared transmittance of deposited films of tellurium, bismuth, antimony and magnesium oxide has been measured. These filters are opaque in the visible region and have short wavelength cut-offs varying from 1 to 3 microns. Reflection filters have also been made, for the region from 10 μ to 40 μ, by roughening the surface of a mirror with emery powder. These filters are used in removing stray radiation from the KBr and KRS-5 regions of the spectrum. A.

535.371

4250. Photoluminescence of sublimate phosphors of zinc sulphide and selenide. K. V. SHALIMOVA. *Dokl. Akad. Nauk SSSR*, **80**, 587–90 (*No.* 4, 1951) *In Russian.*

535.371

4251. The specification of fluorescing materials. J. E. TYLER. Letter in *J. Opt. Soc. Amer.*, **42**, 141 (*Feb.*, 1952).

Light returned from an excited phosphor is partly reflected exciting radiation and partly fluorescence. From measurements of both the total stimulus is arrived at and the trichromatic coefficients obtained. These are presented on the chromaticity chart and a C.I.E. specification given. G. F. J. GARLICK

535.371

4252. Radiofrequency field quenching of ultraviolet excited phosphors. T. MILLER AND K. N. FROMM. Letter in *J. Appl. Phys.*, **23**, 373 (*March*, 1952).

The fluorescence efficiency of orange-red emitting ZnS–CdS phosphors decreases with the potential of an applied alternating electric field (10 Mc/s). Phosphors such as zinc phosphate and zinc silicate are not affected by the field. G. F. J. GARLICK

535.371

4253. Activation of LiI crystal phosphors. W. BERNSTEIN AND A. W. SCHARDT. Letter in *Phys. Rev.*, **85**, 919 (*March* 1, 1952).

LiI crystals activated by Tl, In, Sn and Ag were tested as slow neutron and γ-ray detectors. Sn-activated phosphors gave good response to slow neutrons and offer possibilities of use as detectors of small dimensions (see also abstract following).

G. F. J. GARLICK

535.371

4254. Tin activation of LiI. J. SCHENCK AND R. L. HEATH. Letter in *Phys. Rev.*, **85**, 923 (*March* 1, 1952).

Tin activated LiI (0·1% SnI_2) crystals were used to detect slow neutrons. The 4·8-MeV capture γ-rays gave a pulse distribution with a half-width of 15%. Response to 660 keV electrons was only 1/25 that of a NaI–Tl crystal. G. F. J. GARLICK

535.371

4255. Interactions of remote impurity centers in phosphors. H. W. LEVERENZ AND D. O. NORTH. Letter in *Phys. Rev.*, **85**, 930 (*March* 1, 1952).

Experimental results indicate interaction between Mn centres over several interatomic distances in Zn_2SiO_4–Mn phosphors. Mn concentration has little effect on the emission spectrum but strongly affects the non-radiative loss of energy and the luminescence decay time. G. F. J. GARLICK

535.371 : 537.542

Moded multi-crystalline stilbene for scintillation counting. *See Abstr.* 4425

535.375.5

4256. Raman spectrum of polystyrene. A. PALM. *J. Phys. Coll. Chem.*, **55**, 1320–4 (*Nov.*, 1951).

An experimental procedure is described for measuring the Raman frequencies and depolarization factors of polystyrene. Crawford's double-exposure method was adapted successfully. The accuracy of the results was tested by measurements with purified CCl_4. An assignment of vibrational frequencies is carried out for the Raman lines by comparing the spectrum of polystyrene with those of benzene and styrene. In particular, all frequencies that appear in the Raman spectrum of polystyrene occur in the benzene as well as in the styrene spectrum with the exception of 657 cm^{-1}, 1275 cm^{-1}, 2886 cm^{-1} and 2935 cm^{-1}. A.

535.375.55

4257. The Raman spectra and structures of aluminate and zincate ions. E. R. LIPPINCOTT, J. A. PSELLOS AND M. C. TOBIN. Letter in *J. Chem. Phys.*, **20**, 536 (*March*, 1952).

The observed Raman spectra of the $Al(OH)_4^-$ and $Zn(OH)_4^-$ ions in sodium hydroxide solution are consistent with a T_d symmetry for these ions. A tetrahedral configuration is also indicated by the calculated values of the stretching force constants of the Zn–O and Al–O bonds and the bending force constants of the O–Zn–O and O–Al–O bonds.

G. I. W. LLEWELYN

535.376

4258. On the fluorescence produced by α-particles in stilbene. M. AGENO AND G. CORTELLESSA. Letter in *Nuovo Cim.*, **9**, 196–8 (*Feb.*, 1952) *In Italian.*

Ageno's experiments [Abstr. 1667 (1952)] are extended to a solid crystal of *trans*-stilbene (1·5×2·5×2 cm). They show that part of the energy excited by an α-particle during the first few mm of its travel through the crystal is converted into fluorescent radiations. J. GRANT

535.377

4259. Color centers and thermoluminescence in alkali halides. J. SHARMA. Letter in *Phys. Rev.*, **85**, 692 (*Feb.* 15, 1952).

Experimental measurements were made of the thermoluminescence—temperature curves for powdered specimens of KI, KCl and NaCl and the results related to the thermal bleaching of the colour centres in the crystals. G. F. J. GARLICK

535.39

4260. Determination of the optical constants of solids by photometric measurements. F. ABELÈS. *Rev. Opt. (Théor. Instrum.)* **31**, 127–30 (*March*, 1952) *In French.*

Simple formulae are given which enable the optical constants of a substance to be obtained from measurements, at a given angle of incidence, of the reflectances for light polarized in or perpendicular to the plane of incidence. The method is particularly useful for studying semiconductors in the infrared and a special property of the reflectances of any substance at an incidence of 45° is pointed out. Finally the effect of the errors of measurement on the determination of the optical constants is investigated for a special case. A.

535.39

4261. Optical properties of metallic alloys. S. V. VONSOVSKIĬ, A. A. SMIRNOV AND A. V. SOKOLOV. *Dokl. Akad. Nauk SSSR*, **80**, 353–6 (*No.* 3, 1951) *In Russian.*

Formulae have been derived for the specific conductivity and dielectric permittivity of disordered binary alloys of any structure. It follows from these formulae that the optical constants of such alloys are functions of concentration, the graph of the coefficient of reflection of the Ag–Au alloy having, e.g., the form of a "catenoid" with a minimum at concentration = 0·5. No direct experimental data are as yet available for the near infrared region for which the theory ought to apply in the first place. From the formulae of Sergeev and Chernikhovskiĭ (1934) two alternative formulae have been derived for alloys of any composition and any degree of long-range order in a body-centred lattice. The case of the order–disorder transition has also been discussed, and formulae have been obtained similar to those for ferromagnetic metals. F. LACHMAN

535.39

4262. Anomalous interference films on glass by chemical treatment. F. H. NICOLL. *J. Opt. Soc. Amer.*, **42**, 241–2 (*April*, 1952).

Experimental evidence is given for the formation of films of abnormally high reflecting power, produced by chemical action on glasses of low refractive index. These films are produced by the attack of modified fluosilicic acid under controlled conditions. The results are shown to be due to the formation of double layer films of lower refractive index than the glass and can be accounted for by the unique chemical action. A.

535.39

4263. An early exact solution for the reflectance of reflection-increasing and reflection-reducing films. A. I. MAHAN. *J. Opt. Soc. Amer.*, **42**, 259–62 (*April*, 1952).

The early contributions of M. Poisson and G. B. Airy to the theory of the modern reflection-increasing and reflection-reducing films are discussed. Airy's equations are presented and are used to calculate the reflectance of a MgF_2 film for varying angles of incidence. A restricted form of these equations is also used to calculate the reflectance of a MgF_2 and a ZnS film near normal incidence when the film is illuminated with light of different wavelengths. Comparisons are made between calculated and measured values of the reflectance for some experimental films. Attention is directed particularly to the fact that Airy's equations are very general in form and that many of the more modern solutions for predicting the reflectance of such films can be directly derived from Airy's equations. A.

535.39

4264. A reflectometer for measuring diffuse reflectance in the visible and infrared regions. W. L. DERKSEN AND T. I. MONAHAN. *J. Opt. Soc. Amer.*, **42**, 263–5 (*April*, 1952).

A simple reflectometer to measure diffuse spectral reflectance in the visible and infrared spectral regions is described. The reflectometer is employed in conjunction with the monochromator of a Perkin–Elmer Model 12B spectrometer. A PbS photoconductive cell with a simple bridge circuit is employed as the detector. The long wavelength cut off is at 2·8 microns while the short wavelength limit is defined by the spectral emittance of the W lamp used as the source of radiation. The spectral reflectance of several common materials, including human skin, have been determined. A.

535.41

4265. Optical properties of multiple sandwich thin films. N. CABRERA. *C.R. Acad. Sci.* [*Paris*] **234**, 1045–7 (*March* 3, 1952) *In French.*

A consideration of alternate layers with two distinct thicknesses and refractive indices. The system can be treated as a band-pass filter. Matrix methods lead to formulae with too many parameters. It is shown that it is better to proceed in two steps: (*a*) calculating optical constants for an infinite number of layers; then (*b*) using the result for calculations for a finite number of layers. The matrix method is used for the first part. Curves are given for the case when the optical thicknesses of alternate layers are the same, but refractive indices are 2·4 and 1·3 respectively. S. TOLANSKY

535.412

4266. An unusual kind of fringe system. D. G. DHAVALE. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **64**, 1011–12 (*Nov.*, 1951).

A brief description of patterns formed by superposition of reflected fringe systems from a Newton's ring set-up. These can be obtained with white light or monochromatic light. The bands are localized and are formed from three surfaces. S. TOLANSKY

535.417

4267. The angle mirror interferometer and the new interference effects. J. RIENITZ. *Optik*, **8**, 561–9 (*No.* 12, 1951) *In German.*

A description of the Michelson interferometer in which the two plane mirrors are replaced by either right angle mirrors or right angle prisms. The optical properties of the system are discussed including the sideways displacements of homologous points. The adjustment of the system is simplified. Sideways displacement of a mirror leads to horizontal movement of the fringes in the field. S. TOLANSKY

535.417

4268. Initial adjustment of the Mach–Zehnder interferometer. E. W. PRICE. *Rev. Sci. Instrum.*, **23**, 162 (*April*, 1952).

A relatively simple method is described for adjustment of a Mach-Zehnder interferometer for parallel image planes and for white light fringes. Auxiliary apparatus required consists of one plane mirror and one pinhole, which may be incorporated as permanent parts of the interferometer. A.

535.42

4269. A new form of Abbe's experiment. M. FRANÇON. *C.R. Acad. Sci.* [*Paris*] **234**, 1145–6 (*March* 10, 1952) *In French.*

In the Abbe experiment, a grating viewed by a microscope is only resolved if the direct beam and at least one order of the diffracted light pass into the objective. When only the direct beam is present, the grating image is uniform in intensity. The original form of the grating may be revealed by passing a fine slit across the grating and recording the light passing into the eyepiece with a photocell and galvanometer. Image details below the resolving power of the microscope can be determined. R. W. FISH

535.42

4270. On the mathematical treatment of the width of the slit on Fraunhofer's diffraction phenomenon. II. H. TAKEYAMA, T. KITAHARA AND T. MATUBAYASI. *J. Sci. Hiroshima Univ. A*, **15**, 139–46 (*July*, 1951).

The previous part [Abstr. 6147 (1951)] showed the presence of subsidiary maxima in the Fraunhofer diffraction pattern due to N slits, when the collimator slit is narrow. This paper extends the treatment to the case in which the light incident upon the grating is distributed continuously over a finite angle and does not come from several discrete directions. Agreement with experiment is obtained, although the calculation suggests a fluctuation in intensity of the principal maxima for a wide slit which has not yet been reported experimentally. R. W. FISH

535.42 : 535.822

Three-dimensional diffraction theory of microscope image formation. *See Abstr.* 4285

535.421

4271. Echelette zone plates for use in far infrared spectroscopy. A. WALSH. Letter in *J. Opt. Soc. Amer.*, **42**, 213 (*March*, 1952).

The design is discussed for a reflection type zone plate based on echelette principles to be useful in the region 50–500 μ. The design of an infrared spectrometer using this principle is considered briefly.

S. TOLANSKY

535.421

4272. Error of run in diffraction gratings. D. H. RANK. Letter in *J. Opt. Soc. Amer.*, **26**, 213–14 (*March*, 1952).

Littrow mounted plane gratings and concave gratings are both considered. In the Littrow mount error of run does not reduce the resolving power. The departure from focus produced by error of run in a concave grating is experimentally demonstrated and it is further also shown that there is no deterioration in resolution. The defect leads to marked astigmatism in higher orders. S. TOLANSKY

535.421

4273. Parallel diffraction grating anomalies. C. H. PALMER, JR. *J. Opt. Soc. Amer.*, **42**, 269–76 (*April*, 1952).

Experiments are described which show that grating anomalies are not confined to that part of the incident light which is polarized with its electric vector perpendicular to the rulings. The appearance of the new anomalies is attributed to groove depth. The parallel anomalies have been found only when using gratings with grooves much deeper than the wavelength, and they vanish when the wavelength becomes comparable to the groove depth. It is shown why neither Strong nor Ingersoll found parallel anomalies, and why Rayleigh's theory concludes that they should not exist. New experiments with thin dielectric coats show that very thin layers of dielectric of the order of a fraction of a wavelength thick modify the appearance of both parallel and perpendicular anomalies, although a thickness of about one and one-half wavelengths is required before the anomalous wavelength begins to shift. With thick layers of dielectric, both the parallel and perpendicular anomalies are shifted a calculable amount which depends on the refractive index. A.

535.43

4274. Scattering of visible and near infrared radiation by layered distributions of small metal spheres. E. L. CLEVELAND AND R. C. RAYMOND. *J. Opt. Soc. Amer.*, **42**, 183–6 (*March*, 1952).

The effective scattering cross-sections for metal spheres have been measured through the resonance region, using wavelengths between 0·45 and 15 microns. Spheres of iron and copper sorted into reasonably narrow diameter distributions between 2 and 20 microns were supported in layers on Pliofilm and silver chloride. The results are given in terms of the scattering area coefficient k (the ratio of scattering cross-section to projected area of the spheres) as a function of α (the ratio of sphere circumference to the wavelength used). These results are in general accord with qualitative predictions based on the Mie theory. Detail in the resonance region is obscured by the finite diameter distributions of the samples. A.

535.43

4275. Angular distribution of intensity of light scattered by large droplets of water. R. O. GUMPRECHT, N.-L. SUNG, J. H. CHIN AND C. M. SLIEPCEVICH. *J. Opt. Soc. Amer.*, **42**, 226–31 (*April*, 1952).

The angular distribution of intensity of light scattered by spherical particles whose index of refraction with respect to the surrounding medium is 1·33 has been computed for values of α (circumference of the particle divided by the wavelength of the incident beam) equal to 6·0, 8·0, 10, 15, 20, 25, 30, 35 and 40. The results are presented in tabular form and give the intensities of the two incoherent, plane-polarized components of the scattered light as well as the real and imaginary parts of the complex functions from which the intensities are computed for angles of observation in the range 0° (10°) 170° and 170° (1°) 180°. A sample light-scattering diagram for $\alpha = 40$ is included. The tabulated values were calculated and checked by high speed computers; they extend considerably the range of values previously published. A.

535.434

4276. Light scattering by GR-S solutions. R. TREMBLAY, M. RINFRET AND R. RIVEST. Letter in *J. Chem. Phys.*, **20**, 523 (*March*, 1952).

The amount of scattering by a toluene solution of GR-S (Buna-S type synthetic rubber) is much larger than would be expected. It has been assumed that this is due to microgel, but the effect is still observed when no microgel is present. It is suggested that, as the scattering is a summation of terms involving $(\mu - \mu_0)^2$ (μ and μ_0 are refractive indices of solution and solvent resp.) this will not be zero even if $\mu - \mu_0 = 0$, because of the heterogeneity of composition. More experiments are proposed.

A. J. TAYLOR

535.55

4277. Interpretation of the elasto-optical constants of a crystal of sodium chloride. P. MARCK AND L. TAUREL. *C.R. Acad. Sci.* [*Paris*] **234**, 1066–8 (*March* 3, 1952) *In French.*

The variation of the electric susceptibility of a crystal of NaCl with elastic deformation is determined by considering the variation of the polarizabilities of the ions Na^+ and Cl^-. The variation is compared with that obtained by use of the elasto-optical constants of Pockels and it is concluded that the variation of polarizability introduces a term of second order in the calculation of the elasto-optical constants.

H. G. JERRARD

535.568.1

4278. A photoelectric method for the measurement of small degrees of polarization. H. WILLE. *Optik*, **9**, 84–93 (*No.* 2, 1952) *In German.*

Partly polarized light (e.g. from the solar corona) passes through a rotating half-wave plate and a polarizer so that the polarized component is given a

sinusoidal intensity variation. The a.c. component of the current from a photocell is amplified; high sensitivity is achieved by using a narrow band amplifier ($f = 133$ c/s, $\Delta f = 0{\cdot}4$ c/s) incorporating an RC bridge circuit. The set-up is tested with weakly polarized light obtained by transmission of a beam of unpolarized light through a parallel plate at a small angle of incidence. It is found that with a total intensity of 0·23 ergs per sec it is possible to detect a polarization of about 1 in 10^4. G. F. LOTHIAN

535.568.1

4279. A photoelectric polarimeter for measurement of transient rotations. P. R. CAMP AND R. C. RAYMOND. *J. Opt. Soc. Amer.*, **42**, 237–40 (*April*, 1952).

A polarimeter which permits measurement of transient rotations was built and used to make measurements of the Faraday effect in pulsed magnetic fields. The polarimeter uses two photomultiplier tubes to compare the intensity of an unanalysed fraction of the light to be analysed with a fraction which passes through a fixed analyser. A rapid comparison of the output voltages of the two photocells yields a continuous record of the state of polarization of the incident beam. Measurements can be made in the presence of a large amount of unpolarized light. When the electrical system has a band width of about 200 c/s, a rotation of one minute of arc can be detected. The over-all accuracy of the system as used to measure the Faraday effect is 3%. Dispersion data in the visible are given for the Verdet constants of polystyrene, ethyl laurate and dodecyl acetate. A.

535.65

4280. Tomato classification by spectrophotometry. T. J. SMITH AND R. A. HUGGINS. *Electronics*, **25**, 92–4 (*Jan.*, 1952).

The Agtron is an instrument which compares the light of l.p. Ne lamps and mercury-vapour lamps reflected from a tomato cut in two through red or blue filters. The cut tomato is placed in a drawer and pushed into a cabinet which has its internal surfaces blackened and is furnished with the lamps, the photocells, both of which are 926's, and their associated filters. The output from either one of the photocells, modulated with 120 c/s from the mains supply, can be switched to the input of a 2-stage amplifier followed by a detector and valve voltmeter. Using a standard white disk which reflects red and blue equally, the "red" adjustment is set so that its sensitivity is 10 × that of the "blue." With the tomato halves in position, the reading on "red" is adjusted to full-scale deflection and the meter reading then taken after switching to "blue." This reading is a measure of the ripeness of the tomato, as explained by reference to colour-spectra characteristics. The method eliminates controversy arising from variations in subjective judgments. H. G. M. SPRATT

535.65

4281. Near-circular Adams chromaticity diagrams. I. H. GODLOVE. *J. Opt. Soc., Amer.*, **42**, 204–12 (*March*, 1952).

The Adams chromatic-value diagram has several advantages, including the small effect of Munsell value on the constant-chroma loci, permitting rapi interpolation between value levels; also, chromaticity differences and Munsell notations may be determine directly from the tristimulus values X, Y, Z. But th disadvantages are that the constant-chroma loci c the Munsell Renotation colours, which yield the bes data available, have an ovoid form; and the neutra to-yellow radius is about 72% longer than the neutra to-purple blue radius. The Hunter diagram and on recently proposed by Judd are badly flattened in th yellow region. Various transformations of the Adam variables to yield near-circular contours have no been investigated along with other transformation and more direct studies. The author is concerne mainly with rapid evaluation of colour difference direct from X, Y, Z. Because of the non-congruity o the Renotation contours, compromises must be mad to achieve optimum circularity, hue spacing, straight ness of constant-hue lines, "linearity," constancy o radii, and speed of transformation. For the best o the transformations studied, a table has been prepare to permit immediate reading off of new variables h and v. Two columns contain h for positive and negative values of Adams "H" $= V_X - V_Y$; six more contain values of v for values of Adams "V" $= V_Z - V_Y$ for 3 diagrams, one each "corrected" for colours of chroma 10, 6 and 3, respectively. These are used in the chroma ranges 0–4, 4–8 and 6–16, respectively. When two greatly different chromas are involved, a new colour-difference formula has been derived and tested. While stressing circularity, straightness of hue lines and speed, fairly good results in respect to the other criteria of merit have been obtained. The method is illustrated by application to a series of fadings previously judged visually by a committee of 12 textile-mill men; and the improvement over the Adams method is shown. A.

535.653

4282. Statistics of color-matching data. W. R. J. BROWN. *J. Opt. Soc. Amer.*, **42**, 252–6 (*April*, 1952).

The distribution of colour matches about a colour centre is investigated. Pearson's χ^2 test is used, and the data are found to be normally distributed. A comparison is made between the observed variations of g_{11}, g_{22} and g_{33}, the principal terms of the colour-discrimination tensor and the variations expected from statistical theory. The experimental and theoretical variations are found to agree very closely. Recently published values of g_{ik} are shown to be too small by a factor of two. The reproducibility of colour-discrimination ellipsoids, determined from sets of 30 colour matches, is shown. A.

535.7 : 612.84

Physiological optics. *See Abstr.* 4821–31

535.8

4283. A Schlieren apparatus giving an image in colour. D. W. HOLDER AND R. J. NORTH. Letter in *Nature* [*Lond.*] **169**, 466 (*March* 15, 1952).

This is a normal Schlieren system with a constant deviation prism placed near the light source. The image formed by the mirrors at the knife-edge consists of coloured bands and any deviation of the rays causes a colour change in the final image, instead of the usual intensity change. R. W. FISH

535.822

4284. A high-resolution surface-profile microscope. S. TOLANSKY. *Nature* [*Lond.*] **169,** 445–6 (*March* 15, 1952).

By placing a fine wire or graticule at the field iris of a high-power metallurgical microscope and using an off-centre incident illuminating pencil, a system results which gives a high-resolution surface profile. The method is calibrated interferometrically and can be used with effective magnifications of × 2000. Profile details of less than 0·25 μ both in depth and in extension across the surface can be resolved. The non-destructive advantages, as compared with stylus profilometers are emphasized. The method is illustrated on a fine finished machined metal surface.

S. TOLANSKY

535.822 : 535.42

4285. Three-dimensional diffraction theory of microscope image formation. A. R. STOKES. *Proc. Roy. Soc. A,* **212,** 264–74 (*April* 22, 1952).

The Abbe theory of image formation for a plane object is extended to apply to the case of a three-dimensional object. The diffraction of light by such an object is treated by the standard methods applied to the diffraction of X-rays by crystals. The formation of an image of a three-dimensional periodic object is discussed, and it is shown that certain Fourier components of the structure of the object are reproduced in the image while others are left out. An expression is obtained for the minimum vertical separation between horizontal layers that can just be resolved by racking the microscope up and down; this depends on the scale of the detail in the layers. A.

535.822.9 : 535.41 : 578

4286. Interference microscopy and mass determination. R. BARER. Letter in *Nature* [*Lond.*] **169,** 366–7 (*March* 1, 1952).

The phase change or optical path difference introduced by living cells can be measured by interference microscopy. To find the refractive index, the thickness must be known. An empirical relationship between the refractive index increment and the concentration of protein can be used to determine the latter from the phase change and the projected cell area. This simple method gives good agreement for red blood cells and may have other applications.

R. W. FISH

535.824.32

4287. Brightness diagrams of condensers. G. SCHENDELL. *Optik,* **9,** 33–43 (*No.* 1, 1952) *In German.*

A photocell method for determining the brightness of the field of a microscope is described. The variation of the brightness for a typical microscope with the type and position of the condenser, the diameter of the iris diaphragm and the objective aperture is given in graphical form. R. W. FISH

535.89

4288. A zirconium concentrated-arc infrared source for infrared spectroscopy. M. B. HALL AND R. G. NESTER. *J. Opt. Soc. Amer.,* **42,** 257–9 (*April,* 1952).

Zirconium-oxide concentrated-arc lamps were enclosed in argon-filled, water-cooled jackets provided with rocksalt or thallium bromide-iodide windows. The arcs, so altered, have operated trouble-free for thousands of hours as highly satisfactory infrared spot sources, particularly useful in infrared microspectroscopy. A.

535.89 : 537.542

A stroboscopic mercury vapour light source. *See Abstr.* 4412

HEAT 536

536.1

4289. Approximate solution of a transient heat flow problem. J. H. BLACKWELL AND A. D. MISENER. Letter in *Proc. Phys. Soc.* [*Lond.*] *A,* **64,** 1132–3 (*Dec.,* 1951).

An infinite medium of low conductivity contains a source of heat and some form of thermometer. The thermal constants are determined by inserting a "probe" and recording variation of temperature within the "probe" with time. The solution is outlined together with the experimental procedure.

E. H. DOCK

536.2 : 539.377

4290. Thermal stresses and deformation in elastic bodies with steady two-dimensional heat flow. F. SALZMANN. *Z. angew. Math. Phys.,* **3,** 129–48 (*No.* 2, 1952) *In German.*

General relations between temperature distribution and deformation, using functions of the complex variable $x + iy$, are established. The analysis leads to a particular solution, for which in sections perpendicular to the plane of flow (x, y) stresses do not occur for a steady heat flow without sources or sinks, in a simply connected region. Different examples of temperature distribution with corresponding deformation are presented. Finally the thermal stresses occurring in a hollow cylindrical body with arbitrary cross-section are treated in a general way and special reference is made to stresses in circular tubes. A.

536.21

4291. The thermal conductivity of metals at high temperature. C. L. HOGAN AND R. B. SAWYER. *J. Appl. Phys.,* **23,** 177–80 (*Feb.,* 1952).

The Forbes bar method has been modified and adapted to the problem of measuring the thermal conductivity of metals and alloys in the temperature range from 25°c to 1000°c. A mathematical analysis is presented which indicates the error involved by assuming plane isothermals in the sample. The electrical and thermal conductivities of commercial "A" nickel, Inconel, several stainless steel alloys, and 1010 steel are reported, and the results are compared, qualitatively at least, with the theory presented by Wilson (1937) and Makinson (1938). A.

536.21

4292. Approximations in transient surface heating. J. C. JAEGER. *Aust. J. Sci. Res. A,* **5,** 1–9 (*March,* 1952).

A number of exact solutions for the surface temperature of a semi-infinite solid which is heated over a region of its surface is given. These have applications

to edge effects in surface induction heating, to the heating of the anode of an X-ray tube, and to heating by friction. The regions discussed are a half-plane, a strip, a square, a rectangle and a circle. Temperatures within the solid and the way in which they approximate to those of a continuous point source are discussed. Holm's approximation (heating of the region bounded internally by a sphere [Abstr. 3295 (1948)] and heat generation over a spherical region are also studied. A.

536.21

4293. A steady-state heat flow problem for a quarter infinite solid. W. KARUSH. *J. Appl. Phys.*, **23**, 492–4 (*April*, 1952).

The steady-state temperature field $T(x, y)$ in a homogeneous solid $x \geqslant 0$, $y \geqslant 0$, z arbitrary is studied when the flow out the face $y = 0$ is a prescribed function $g(x)$. Along the face $x = 0$ either the condition $T = 0$ or $k(\partial T/\partial x) = hT$ is assumed. Of especial interest is the temperature at the face $y = 0$ and the flow at the face $x = 0$; particular attention is paid to the case $g(x) = 0$ for $x > a > 0$. The results have application to situations in which heat is being drawn off at the corner of a solid. A.

536.22

4294. The thermal conductivity of liquid oxygen. S. PROSAD. Letter in *Brit. J. Appl. Phys.*, **3**, 58–9 (*Feb.*, 1952).

The Nusselt equation for estimating the heat transfer coefficient for condensing pure saturated vapour on a vertical surface is applied to the condensation of O_2 vapour at 1–1·7 atm., on the outside of a vertical Cu tube. The latent heat is absorbed by boiling O_2 within the tube. In the range $-179{\cdot}6$°c to -182°c there is good agreement with extrapolated values due to Hammann, the mean value being $5{\cdot}05 \times 10^{-4}$ cal/cm/sec/°c. E. H. DOCK

536.24

4295. Engineering aspects of liquid metals for heat transfer. T. TROCKI. *Nucleonics*, **10**, 28–32 (*Jan.*, 1952).

The merits of liquid metal coolants are described and the properties of a number of heat transfer fluids including:—Na; NaK (44% K); HTS ($NaNO_2 + NaNO_3 + KNO_3$); Dowtherm A (diphenyl–diphenyl oxide eutectic); Hg; Pb; Pb–Bi eutectic; Li and water are tabulated. Handling and safety problems are discussed. The design of liquid metal heat exchangers, in particular liquid metal to steam generators and the use of electromagnetic pumps are outlined. L. R. SHEPHERD

536.3

4296. Heating in vacuo by an external radiation source. A. LEEMANS AND R. KOMPFNER. Letter in *Vacuum*, **1**, 203–4 (*July*, 1951).

A W filament lamp at temperature T_1 is placed at one focus of an ellipsoidal mirror and the radiation reflected from the lamp heats the object, which is *in vacuo* and at the other focus, to temperature T_2. Tests have shown that the relation $T_2^4 = T_1^4 FE(a-f)^2/(a+f)^2$ is approximately confirmed. F and E are factors which allow for the incomplete ellipsoid reflector and for radiation losses respectively; a is the longer half-axis and f the distance of the focus from the centre of the ellipsoid. Various practical uses for the concentrated heat source are given. S. WEINTROUB

536.411

4297. The thermal expansion of water and 1-propanol. C. B. KRETSCHMER. *J. Phys. Coll. Chem.*, **55**, 1351–5 (*Nov.*, 1951).

An investigation of the thermal expansion of water and of 1-propanol shows no evidence of a discontinuity in the coefficient of expansion of either liquid nor of any slow temporal change in the density of 1-propanol, both of which types of anomalous behaviour have been reported by Antonoff [Abstr. 1761 (1944), 6157 (1949)]. The density of 1-propanol from 0° to 75°c can be represented by the equation $d_4^t{}^\circ = 0{\cdot}819302 - 7{\cdot}8824 \times 10^{-4}t + 5{\cdot}925 \times 10^{-8}t^2 - 8{\cdot}550 \times 10^{-9}t^2$. A.

536.423.15

4298. The vapour pressure of ethylene. A. MICHELS AND T. WASSENAAR. *Physica*, **16**, 221–4 (*March*, 1950).

The vapour pressure of C_2H_4 has been measured between -125°c and $+8$°c and it is represented as a function of temperature by a formula, containing four constants. A.

536.423.15

4299. Vapour pressure of liquid xenon. A. MICHELS AND T. WASSENAAR. *Physica*, **16**, 253–6 (*March*, 1950).

The vapour pressure of liquid xenon has been measured between -110° and $+16$°c. The results are represented as a function of temperature by a formula, containing four constants. A.

536.423.15

4300. The vapour pressure of carbon monoxide. A. MICHELS, T. WASSENAAR AND T. N. ZWIETERING. *Physica*, **18**, 160–2 (*March*, 1952).

This was measured between -180°c and -140°c. Results are represented as a function of temperature by the formula $\log P = A/T + B \log T + CT + D$. A.

536.423.15

4301. Vapor pressure of benzene above 100°c. P. BENDER, G. T. FURUKAWA AND J. R. HYNDMAN. *Industr. Engng Chem.*, **44**, 387–90 (*Feb.*, 1952).

The vapour pressure has been accurately established for pressures below 2 atm. in the higher temperature range, up to the critical point, for which no general agreement has as yet been achieved. The apparatus and experimental procedure employed were tested through measurements on water. The results for benzene converged satisfactorily to agreement with the confirmed values at lower pressures, and in general their accuracy is estimated at 0·1%. Comparisons have been made with all pertinent data previously reported. Values are also given for the critical constants as obtained through compressibility measurements in the critical region. A.

536.423.15 : 532.77 : 536.7

4302. The thermodynamics of hydrocarbon solutions. I. Technique of vapour-pressure measurements; the vapour pressure of benzene. P. W. ALLEN, D. H. EVERETT AND M. F. PENNEY. *Proc. Roy. Soc. A*, **212**, 149–63 (*April* 22, 1952).

A technique has been developed for the accurate determination of vapour pressures of liquids in the

emperature range 0 to 80°c and pressure range 5 to 760 mm of mercury. Measurements were made of he vapour pressure of carefully purified benzene, nd results obtained in satisfactory agreement with he best recent work. The standard deviation of the mean of eight determinations varies from ± 0·02 mm t 25°c to ± 0·11 mm at 75°c. A.

536.423.15 : 532.77 : 536.7

4303. The thermodynamics of hydrocarbon solutions. II. The systems benzene + diphenyl, benzene + diphenylmethane and benzene + dibenzyl. D. H. Everett and M. F. Penney. *Proc. Roy. Soc. A*, **212**, 164–76 (*April* 22, 1952).

The vapour pressures of benzene solutions of diphenyl, diphenylmethane and dibenzyl were measured over the temperature range 25 to 75°c. Small deviations from Raoult's law are observed, which are positive for diphenyl and negative for diphenylmethane and dibenzyl solutions. Activity coefficients (γ) were calculated after correcting the data for imperfection of the benzene vapour. The final results are compared with the theoretical equations deduced by Orr and by Guggenheim for mixtures of monomers and dimers. In the range of mole fractions up to 0·6 of non-volatile component the agreement between theory and experiment is within ± 0·0015 in $\log_{10}\gamma$ when the energy of interaction between molecules is taken as independent of temperature and the number of nearest neighbours (z) is six. The energy of interaction in the case of diphenyl leads to a heat of mixing in satisfactory agreement with that measured calorimetrically by Tompa. The energy of mixing Nw, where w refers to z nearest neighbour contacts, and N is the Avogadro number, is 640 J (153 cal) for diphenyl, 264 J (63·0 cal) for diphenylmethane, and 295 J (70·5 cal) for dibenzyl. For diphenyl solutions there is evidence of a systematic deviation between theory and experiment which exceeds the limits given above only in concentrated solutions. More detailed analysis suggests that the discrepancy is to be attributed to deviations of the entropy from the theoretical value. Baxendale and Enüstün's conclusions that both heat and entropy effects contribute to the deviations, and that the parameter w depends on the composition of the solution, are considered to be premature. A.

536.424

4304. Effect of the heat of transformation of solids on the shift of their temperature of transformation by adsorbed gases. J.-P. Kiehl. *C.R. Acad. Sci.* [*Paris*] **234**, 943–5 (*Feb.* 25, 1952) *In French.*

Experiments conducted with Tl, SnO_2, AgI, KNO_3, $AgNO_3$, and Na_2MoO_4 in the atmospheres of CO_2, Ar, N_2, Ne and H_2, have shown that (1) the lowering of the temperature of polymorphic transformation of the above solids depends to a large extent on their heats of transformation; and (2) the amplitude of this lowering is a decreasing function of the heat of transformation, the decrease being very pronounced for solids with a low molar heat of transformation.

F. LACHMAN

536.424

4305. The allotropic transformation of hafnium and a tentative equilibrium diagram of the system zirconium–hafnium. J. D. Fast. *J. Appl. Phys.*, **23**, 350–1 (*March*, 1952).

The temperature of the transformation in Hf is at least 550°c higher than the value recently reported by Duwez (1310° ± 10°c). A tentative equilibrium diagram of the system Zr–Hf is given. A.

536.424 : 548.736.4

4306. On the phase transition in lead titanate. G. Shirane and S. Hoshino. *J. Phys. Soc. Japan*, **6**, 265–70 (*July–Aug.*, 1951).

Permittivity measurements from −170°c to 580°c give a Curie point at 490°c. Powder photographs show that the low temperature phase is tetragonal with axial ratio and cell volume decreasing as the Curie point is reached; it is cubic above 490°c. The volume change is confirmed by dilatometer. Mean expansivity: -18×10^{-6} (40–440°c) and 25×10^{-6} (> 490°c). Specific heat shows a λ-anomaly with transition energy ~1150 cal/mole. See also abstracts following, and Abstr. 3568 (1952). R. O. DAVIES

536.424 : 548.736.4

4307. On the phase transition in barium–lead titanate. I. G. Shirane and K. Suzuki. *J. Phys. Soc. Japan*, **6**, 274–8 (*July–Aug.*, 1951).

Permittivity and lattice constants are measured from −170°c to 580°c over the whole range of compositions. Pure $BaTiO_3$ has three transitions with Curie points at −70, 5 and 120°c. With increasing Pb content the first two drop rapidly below the limit of observation while the third increases steadily to $T_c = 490$°c for pure $PbTiO_3$. At 30°c there is tetragonal symmetry with an axial ratio increasing from 1·008 (pure $BaTiO_3$) to 1·063 (pure $PbTiO_3$). See also preceding abstract. R. O. DAVIES

536.424 : 548.736.4

4308. On the phase transition in barium-lead titanate. II. G. Shirane and A. Takeda. *J. Phys. Soc. Japan*, **6**, 329–32 (*Sept.–Oct.*, 1951).

Measurements over 0–500°c show that (1) the expansion coefficient of the tetragonal (low temperature) phase becomes negative with increasing Pb content (this is attributed to a decrease in spontaneous polarization) and (2) the transition energy as estimated from C_p curves increases from 40 cals/mole (0% $PbTiO_3$) to 1100 cals/mole (100% $PbTiO_3$). The expansion experiments also show that hysteresis increases with Pb content and this is confirmed by some oscilloscope measurements at 50 c/s. See also Abstr. 3569 (1952). R. O. DAVIES

536.44 , 536.71

4309. The shape of the coexistence curve in the critical region. B. H. Zimm. Letter in *J. Chem. Phys.*, **20**, 538 (*March*, 1952).

It is suggested that the data of Rowden and Rice on the coexistence curve of aniline and cyclohexane, from which they conclude that the curve has a flat top, are equally consistent with the existence of a cubic coexistence curve. Such cubic coexistence curves have been found for a number of other systems. The cubic equations may be written in the same form so that found by Guggenheim for gas–liquid data when the single constant in the equation is remarkably constant for very different systems. F. E. HOARE

536.44 : 536.71

4310. Change in thermodynamic properties along isentropes at the coexistence line far from the critical point. S. G. Reed, Jr. Letter in *J. Chem. Phys.*, **20**, 539 (*March*, 1952).

Calls attention to the fact that for a single component system the abrupt change in slope of an isentropic curve on a p–v diagram in passing through the coexistence line may be calculated to a fair approximation in the region of volumes much larger than the critical value. Expressions are deduced for $(\partial p/\partial v)_s$ at the coexistence line for the liquid–vapour mixture by assuming L constant and neglecting the volume of the condensed phase. It is stated that only a small error is made in using the perfect gas equation to calculate $(\partial p/\partial v)_s$ for the vapour phase. Nitrogen at 65°K is quoted as an example of the abrupt change of slope at the coexistence line. F. E. HOARE

536.45 : 531.552

4311. Phenomena associated with the flight of ultra-speed pellets. III. General features of luminosity. J. S. Rinehart, W. A. Allen and W. C. White. *J. Appl. Phys.*, **23**, 297–9 (*March*, 1952).

For Pt II, see Abstr. 3432 (1952). Ultra-speed pellets of the lighter metals such as Al and Mg generate intensely luminous trails when fired through air. A pronounced characteristic of the luminous trails is the intermittent manner in which the light is emitted. This effect has also been observed in meteors and in studies of conventional shaped charges. Photographs indicate that flashing is caused by yawing of the pellet. The brilliant flashes of light are associated with the ablation and subsequent burning of material from the pellet. There is evidence that the material is removed from the pellet in the form of small droplets. The brightness, luminous output, and temperature of the trail generated by an Al pellet have been measured. The brightness is approximately 25 000 lamberts, the luminous output is 30 000 lumen-seconds and the colour temperature is 2900°K. A.

536.46

4312. Burning velocity determinations. VII. The burning velocities of some ethylene + oxygen + nitrogen mixtures. H. S. Pickering and J. W. Linnett. *Trans Faraday Soc.*, **47**, 1101–6 (*Oct.*, 1951).

For Pt VI, see Abstr. 1265 (1952). The effect of pressure on the burning velocity of some ethylene + air mixtures has been examined by the soap bubble method. The burning velocity measured is found to be unaffected by changes in pressure. This result is different from that obtained by Linnett and Wheatley using the burner method who found that the burning velocity increased as the pressure was lowered. No certain explanation of the difference can be given. The burning velocities, at atmospheric pressure, of some ethylene + oxygen + nitrogen mixtures containing 9% ethylene and from 19 to 91% oxygen were determined. Calculations of equilibrium flame temperatures and radical concentrations were made for these mixtures. The results were considered in relation to the radical diffusion and thermal conduction theories of flame propagation and an attempt made to assess the possible importance of the differe atoms and radicals in the various gas mixtures.

536.4

4313. Some properties of plastics and the use plastic apparatus at low temperatures. W. Giauque, T. H. Geballe, D. N. Lyon and J. Fritz. *Rev. Sci. Instrum.*, **23**, 169–73 (*April*, 1952).

Some properties of methyl methacrylate plast were investigated at low temperatures to supply desig data needed for the construction of plastic apparatu The diffusion rates for air and helium were measure at temperatures from 260 to 300°K. The diffusio coefficient k (expressed as cm³ (N.T.P.) sec^{-1}(cr Hg^{-1})) is given roughly by the following relation $\log_{10} k = [(-2{\cdot}85\times10^3)/T] - 1{\cdot}68$ for air an $\log_{10} k = [(-1{\cdot}28\times10^3)/T] - 4{\cdot}95$ for He. Th change in length of a 30 cm rod was measured a 298·7°, 273·16°, 194·7°, 77·3° and 20·4°K by com parison with quartz using a depth micrometer gauge The coefficient of expansion is tabulated as a functio of temperature, increasing from $0{\cdot}6\times10^{-5}$ at 20°K t $8{\cdot}0\times10^{-5}$ at 300°K. Hysteresis and geometrica distortion accompanying cooling are shown to b very small. Complex apparatus containing man seals, including various sorts of electrical leads, ha been shown to be vacuum tight when tested in liqui helium II. A method of connecting a vacuum line a room temperature and a plastic apparatus at low temperatures by means of a metal tube liner-dilute rubber cement seal is described. The adsorption o He gas has been measured at 4·2 and 1·2°K and a pressures from 4×10^{-4} to 4×10^{-1} mm. A

536.48

4314. Experiments on the unsaturated helium II film. R. Bowers, D. F. Brewer and K. Mendelssohn. Letter in *Phil Mag.*, **42**, 1445–8 (*Dec.*, 1951).

Describes experiments on the transfer rate of the He II film at pressures lower than the vapour pressure of the liquid. Appreciable transfer occurs only near saturation. R. B. DINGLE

536.48

4315. Film transfer in helium II below 1°K. E. Ambler and N. Kurti. Letter in *Phil. Mag.*, **43**, 260–4 (*Feb.*, 1952).

After the flat portion between 1·5°K and 0·8°K the transfer rate shows a further increase which amounts to 30% at 0·2°K. H. LONDON

536.48

4316. Helium II transfer on metal surfaces. B. S. Chandrasekhar and K. Mendelssohn. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 226–7 (*March*, 1952).

Stainless steel beakers of very good finish give abou the same transfer rate as glass. The rate increased after destruction of the finish by heating. This supports the hypothesis previously advanced, tha the increased rate observed on Pt and Ni [Abstr. 180 (1951)] is due to surface cracks. H. LONDON

536.4

4317. Some experiments on flow in the unsaturate helium II film. E. Long and L. Meyer. *Phys. Rev.* **85**, 1030–5 (*March* 15, 1952).

The mass flow in adsorbed layers of helium wa measured. Superfluidity occurs at all temperature

below the λ-temperature of the bulk liquid down to 1½ statistical layers. The bearings of these results on the thermodynamics of transition He I — He II in adsorbed layers is discussed. A.

536.52

4318. A sonic-flow pyrometer for measuring gas temperatures. G. T. Lalos. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 179–90 (*Sept.*, 1951).

The measuring element is located in the throat of a nozzle through which the gas, whose temperature is to be measured, is caused to flow at sonic velocity. In accordance with theory and experiment, the total temperature of the gas is obtained by multiplying the temperature indicated by the measuring element by an essentially constant correction factor. Tests on experimental units indicate that these have many advantages over conventional instruments when used in the evaluation and control of gas turbines and jet engines. A.

536.521

4319. A brightness temperature pyrometer using a photoconductive cell. E. C. Pyatt. *J. Sci. Instrum.*, **29**, 125–7 (*April*, 1952).

A PbS photoconductive cell is used as the balance detector in a low temperature pyrometer employing a null method. The cell is alternately exposed to radiation from the unknown hot body and from a lamp contained in the instrument. The output from the cell which is amplified by a tuned amplifier is adjusted to zero by changing the current through the lamp. The lamp current can be calibrated in terms of black body temperature. The instrument described has three temperature ranges—150–220°C, 210–330°C and 300–500°C—obtained by inserting different absorption screens in the path of the radiation from the lamp. Corresponding effective wavelengths are 2·45 μ, 2·35 μ and 2·20 μ. A modification of the instrument to produce a temperature range of 100–175°C is also described. The measurement accuracy throughout these ranges is ±5°C for a single reading. A.

536.531

4320. A new method of converting platinum resistance values to degrees centigrade. F. D. Werner and A. C. Frazer. *Rev. Sci. Instrum.*, **23**, 168–9 (*April*, 1952).

Values of temperature in degrees C are conveniently derived from values of resistance of a platinum resistance thermometer by means of a table of temperature *v.* resistance. Since each thermometer has its own fundamental constants, it becomes laborious to prepare separate tables for different thermometers. This labour may be avoided by interpolation from a single "standard" table, applying corrections which have been worked out in a reasonably compact form to use the constants of each particular thermometer. A standard table and its correction table are given and were calculated by a rapid method which is outlined. A graph is the most convenient form for the corrections to this standard table. The procedure for making these corrections is discussed. In addition a graphical means of conversion is discussed, which is accurate to 0·01°C and is very convenient and rapid where this accuracy is adequate. A.

536.532

4321. Behaviour of platinum/platinum–rhodium thermocouples at high temperatures. H. J. Svec. Letter in *J. Sci. Instrum.*, **29**, 100 (*March*, 1952).

When a Pt/Pt–Rh thermocouple was used in a beryllium oxide two-hole insulator the refractory was eroded at the hot end and crystals of Be metal were deposited at the cold end after a long period at 1500°–1600°C. Alundum insulators were also eroded but there was no crystalline deposit. The couple wire showed a loss of Rh and this confirms the findings of R. C. Jewell and E. G. Knowles. E. H. Dock

536.63 : 536.48

4322. The specific heats of germanium and grey tin at low temperatures. R. W. Hill and D. H. Parkinson. *Phil. Mag.*, **43**, 309–16 (*March*, 1952).

The specific heats of germanium and grey tin have been measured from liquid helium temperatures up to 170° and 110°K respectively. A comparison of the results with existing data shows that previous measurements on germanium do not represent the behaviour of the pure material, whereas those for grey tin are satisfactory. It is also shown that the temperature variations of the Debye characteristic temperatures of these elements are very large, and qualitatively similar to those of diamond and silicon. This behaviour is thought to be characteristic of lattices of diamond structure, but the possibility of the existence of anomalous contributions to the specific heat is also discussed. Values of the enthalpy, entropy and free energy of both substances have been calculated as a function of temperature and are presented in tabular form. A.

536.631

4323. Theory of the specific heat of graphite. K. Komatsu and T. Nagamiya. *J. Phys. Soc. Japan*, **6**, 438–44 (*Nov.–Dec.*, 1951).

The graphite crystal is considered as a system of thin elastic plates spaced at a constant distance. An elastic force is assumed to act between each neighbouring plate in such a way that a local change of the spacing between them produces at that point a tension or a pressure normal to the plates whose magnitude is proportional to that change. The vibrations of this system are assumed to be separable into independent parts: the bending vibrations in which the displacements occur normal to the planes of the plates, and the extensional and shearing vibrations in which the displacements occur parallel to them. The frequency distributions of their normal modes are studied. The values of the elastic constants of the plates that determine the latter vibrations are derived from the force constants of benzene molecule, while the value of the bending modulus of the plate is determined by fitting the calculated specific heat curve with the observed one. The constants of the elastic force acting between neighbouring plates are derived from the measured elastic constants of graphite (mainly the compressibility). Small contributions of the electronic specific heat and the $C_p - C_v$ correction are added to obtain the total specific heat. The result is in good agreement with experiment. A.

THERMODYNAMICS 536.7/.8

536.7

4324. An introduction to modern thermodynamical principles. Second Edition. A. R. UBBELOHDE. *London, Oxford University Press* (1952) 194 *pp.*

"Since the first edition . . . new sections have been added . . . to deal with experimental and theoretical progress in the thermodynamics of condensed phases, in such fields as melting, rubber-like solids, molecules of high molecular weight, and the formal thermodynamics of continuous phase transitions. A chapter has been added to illustrate applied calculations of thermodynamic functions in cases of current importance."

536.7

4325. Derivation of the second fundamental principle for reversible processes. K. FEUCHTINGER. *S.B. Öst. Akad. Wiss. IIa,* **159,** 407–15 (*No.* 9–10, 1950) *In German.*

Starting with the equation $pv = RT$ the efficiency of a Carnot cycle with a perfect gas as working substance may be shown to be $(T_1 - T_2)/T_1$. It is shown that the general validity of this expression, with any arbitrary working substance, may be established from the general principle that the efficiency of any reversible cyclic process approaches 100% as the sink temperature approaches the absolute zero. From this the general mathematical statement of the second law follows. F. E. HOARE

536.7

4326. Thermodynamic properties of carbon monoxide at temperatures between 0°C and 150°C and at densities up to 600 amagat. A. MICHELS, R. J. LUNBECK AND G. J. WOLKERS. *Physica,* **18,** 128–34 (*Feb.*, 1952).

From the compressibility isotherms of carbon monoxide [Abstr. 4172 (1952)] the values of energy (U), entropy (S), kinetic energy (K), free energy (F) enthalpy (H), free enthalpy (G) and specific heats (C_P and C_V) have been calculated for integral values of temperature between 0° and 150°C and for densities up to 600 amagat (approximately 3000 atmospheres). A.

536.7

4327. On the principle of thermal interaction. H. HOLTAN, JR. Letter in *J. Chem. Phys.*, **20,** 526 (*March*, 1952).

A reply to a criticism by P. Mazur [Abstr. 978 (1952)] of a former paper. F. E. HOARE

536.7

4328. Thermodynamics of three-component systems. H. A. C. MCKAY. Letter in *Nature* [*Lond.*] **169,** 464–5 (*March* 15, 1952).

Thermodynamic relations of the type $(\partial \ln a_1/\partial n_2)_{n_1,n_2} = (\partial \ln a_2/\partial n_1)_{n_2,n_3}$ where a is activity and n mole number appear in the literature but relations of the type $(\partial \ln a_1/\partial n_2)_{a_2,n_3} = (\partial \ln a_2/\partial n_1)_{a_1,n_3}$ and $(\partial \ln a_1/\partial \ln a_2)_{n_1,n_3} = -(\partial n_2/\partial n_1)_{a_2,n_3}$ do not appear although their use is sometimes more convenient than the first type. It is shown how the use of such relations may in certain cases enable the activities of two components to be calculated absolutely from measurements of the activity of a sing component as a function of composition. In th case of an aqueous solution of two electrolyte the activities of both may be calculated from vapou pressure measurements alone. The cross differentia tion relations also throw new light on Harned's rul The application of the relations to partition equilibri and to ion exchange equilibria is also indicated.

F. E. HOAR

536.7

4329. Polytropic exponent of isentropic expansion in the coexistence region. S. G. REED, JR. Letter i *J. Chem. Phys.*, **20,** 533–4 (*March*, 1952).

The constant κ in the relation $pv^\kappa = \text{const.}$ a applied to isentropic expansions in the coexistenc region of two phases in equilibrium is often regarde as purely empirical. It is shown how an exac expression may be deduced for κ in terms of other measurable, thermodynamic properties. An approxi mate form is also given. Calculation shows the exac value of κ to be in excellent agreement with the empirical value at the coexistence line. F. E. HOARE

536.75

4330. Physical entropy and information. D. A. BELL. Letter in *J. Appl. Phys.*, **23,** 372–3 (*March*, 1952).

Raises the question of whether analogies between entropy of information theory and of thermo-dynamics have thrown into relief a point glossed over in the past, i.e. is Boltzmann's constant k to be regarded as a pure number whilst temperature has the dimensions of energy? Several analogies are given to introduce and illustrate the point at issue.

F. E. HOARE

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.11

4331. Radiation capacity. H. WEYL. *Proc. Nat. Acad. Sci.* [*Wash.*] **37,** 832–6 (*Dec.*, 1951).

The classical notion of capacity in electrostatic fields is extended to scalar radiation fields.

R. A. NEWING

ELECTROSTATICS . DIELECTRICS 537.2

537.226.2/.3

4332. Microwave absorption and molecular structure in liquids. VII. Effects of viscosity and dipole–dipole forces. A. J. CURTIS, P. L. MCGEER, G. B. RATHMANN AND C. P. SMYTH. *J. Amer. Chem. Soc.*, **74,** 644–8 (*Feb.* 5, 1952).

For Pt VI, see Abstr. 8729 (1950).

537.226.2/.3

4333. The dielectric properties of systems containing straight polar chains. R. A. SACK. *Aust. J. Sci. Res. A*, **5**, 135–45 (*March*, 1952).

A mathematical derivation is given of the dielectric properties of systems containing straight polar chains such that to each value of the total moment of a chain there corresponds only one arrangement of its dipoles. If the moments of the individual dipoles and the probability of an elementary transition are fixed, both the total dielectric loss and the effective relaxation time of the system increase in proportion to the square of the number of states of each chain. These conclusions are not valid for kinked chains and apply only qualitatively if the chains are branched. The theory provides an explanation for the high dielectric losses at low frequencies observed in many solids containing hydroxyl groups. It can further explain the low frequency absorption found in ionic crystals containing lattice imperfections; in this interpretation the theory is related to Jaffé's theory of conductivity in polarizable media (1933). A.

537.226.2

4334. Dielectric properties of some clathrate compounds of quinol. J. S. DRYDEN AND R. J. MEAKINS. Letter in *Nature* [*Lond.*] **169**, 324 (*Feb.* 23, 1952).

Data are given for β-quinol with methanol, hydrogen sulphide, hydrogen cyanide, methyl cyanide and sulphur dioxide. For the first three, ε' is enhanced proportional to the square of the dipole moments, indicating orientation. For methyl cyanide there is only a small enhancement, since the larger size causes a distension of the quinol lattice. C. TURNER

537.226.2

4335. A simple method for determining the dielectric constants of liquids in the cm-wave region. F. REDER AND E. HAFNER. *Acta Phys. Austriaca*, **5**, 189–201 (*No.* 2, 1951) *In German.*

Uses a filled coaxial line with a closed end which is not reached by a moveable central conductor. λ and hence ε is observed by moving the central conductor and tan δ by varying the frequency off resonance. The method is used for solids, liquids or powders; the accuracy claimed is 5 in 10^4.

D. H. WHIFFEN

537.226.2

4336. On the electret. Y. KAKIUCHI. Note in *J. Phys. Soc. Japan*, **6**, 278–9 (*July–Aug.*, 1951).

Of the separated components of Eguichi's electret mixture of carnauba wax and rosin, only the free wax alcohols show strong electret properties, although mixtures of the other components, e.g. esters and abietic acid are weak electrets. J. H. MASON

537.226.2

4337. Critical domain size in ferroelectrics. W. KÄNZIG AND M. PETER. Letter in *Phys. Rev.*, **85**, 940 (*March* 1, 1952).

Small particles of non-conducting KH_2PO_4 were found to be single domains if the size is less than about 1500 Å, while no single domain characteristics were observed for even the smallest particles of KD_2PO_4, which is a conductor of electricity.

E. P. WOHLFARTH

537.226.2

4338. Electrification of "Perspex" under compression. M. J. MORANT AND W. K. MANSFIELD. Letter in *Nature* [*Lond.*] **169**, 499–500 (*March* 22, 1952).

No effect was detectable using parallel plate electrodes. When one electrode was a point of 0·2 mm radius a potential of 60 mV was observed for a load of 1·8 kg (point positive). Similar potentials were found with a Hg drop in place of the point, a very small load then sufficing. The effect is interpreted in terms of bound surface charges on the dielectric, the observable potential being proportional to change in contact area. F. F. ROBERTS

537.226.2

4339. Dielectric constant in perovskite type crystals. J. H. BARRETT. *Phys. Rev.*, **86**, 118–20 (*April* 1, 1952).

Slater's theory of the dielectric constant in $BaTiO_3$ has been extended by treating the ionic polarizability quantum mechanically instead of classically. This leads to an expression for the dielectric constant which is good at all temperatures and shows a deviation from the Curie–Weiss law at low temperatures. The theory is applied to $SrTiO_3$ and to $KTaO_3$ above its transition at 13·2°K.

537.226.2 : 536.413

4340. Adiabatic study of the 128°C transition in barium titanate. S. ROBERTS. Letter in *Phys. Rev.*, **85**, 925 (*March* 1, 1952).

Evidence for a latent heat which would characterize a first-order transition in $BaTiO_3$ is presented and an experimental lower limit of 15 cal/mole is obtained.

C. A. HOGARTH

537.226.3

4341. An empirical minimum dielectric loss relationship. G. E. CROUCH, JR. *J. Phys. Coll. Chem.*, **55**, 1279–85 (*Nov.*, 1951).

An attempt is made to place on a common analytical basis the consideration of the dielectric behaviour of a group of heterogeneous polymeric materials for the purpose of predicting certain dielectric properties of a hypothetical material. The possibility of incorporating these properties in an actual polymeric material is of practical interest. An expression for the complex dielectric constant of a solid is obtained. From this expression predictions of minimum dielectric loss for a hypothetical material are made and correlations with actual materials drawn. A.

537.226.3

4342. Dielectric relaxation in sulfuric acid. J. C. D. BRAND, J. C. JAMES AND A. RUTHERFORD. Letter in *J. Chem. Phys.*, **20**, 530–1 (*March*, 1952).

The dielectric constant and total dielectric loss factor were determined. The static dielectric constant is ~110, characteristic of polar liquids where H-bonding gives short-range cooperative effects of molecular dipoles. J. JACOBS

537.226.31

4343. On high frequency power loss of dielectrics. K. HIGASI AND Y. OZAWA. Note in *J. Phys. Soc. Japan*, **6**, 280–1 (*July–Aug.*, 1951).

Measurements on methyl palmitate by Jackson [Abstr. 257 (1950)] and Cook and Buchnan [Abstr.

4949 (1950)] show that there are no maxima in the effective conductivity-frequency characteristic, in contrast to that for power factor and frequency. Reference to Frohlich's formula for resonance absorption shows that the h.f. conductivity serves both as a criterion for resonance absorption and as a measure of power loss. J. H. MASON

537.226.8

4344. Note on the dielectric constant of pure hydrogen peroxide as a function of temperature. TALAT-ERBEN. *Bull. Soc. Chim. France*, **19**, 176 (*Jan.–Feb.*, 1952) *In French.*

The experimental results of Gross and Taylor [Abstr. 6480 (1950)] justify the dielectric constant equation previously suggested [Abstr. 279 (1952)]. D. H. WHIFFEN

537.228.1 : 621.3.012.8 : 621.396.611.21

4345. Circle diagram for resonance curve of piezo-electric quartz. J. COULON. *C.R. Acad. Sci.* [*Paris*] **234**, 1138–40 (*March* 10, 1952) *In French.*

The admittance of a quartz resonator is expressed in a form which lends itself to representation as a circular diagram, the properties of which are described. H. J. H. STARKS

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 537.533 : 530.162

4346. Null method comparison of the thermal noises of certain materials. V. S. TROITSKIĬ, A. G. LYUBINA AND A. V. ZOLOTOV. *Dokl. Akad. Nauk SSSR*, **80**, 583–6 (*No.* 4, 1951) *In Russian.*

A simple, direct and precise method is described. General conclusions are reached for comparison of thermal noises of roughly similar amplitudes. Theoretical deductions are supported by experimental data. Z. F. WOJNAR

537.311 : 536.48

4347. Measurements on the current sensitivity of the electrical resistance of condensed iron films at low temperatures. A. VAN ITTERBEEK, R. LAMBEIR, B. FRANKEN, G. J. VAN DEN BERG AND D. A. LOCKHORST. *Physica*, **18**, 137–44 (*March*, 1952).

The measurements were carried out on evaporated layers. The results are discussed on the basis of the theoretical equations, established by Gorter and Mostovetch respectively. Measurements were also carried out down to liquid helium temperatures on the change of the electrical resistance in a magnetic field, which is parallel to the current. Hysteresis loops have been obtained, which depend on temperature. The results obtained are related to the theory of Kittel for domain structure of iron films. A.

537.311.31

4348. On the alteration of the electrical resistance of pure metals at the melting point. H. GERSTENKORN. *Ann. Phys.* [*Lpz.*] **10**, 49–79 (*No.* 1–2, 1952) *In German.*

A calculation is made of the resistivities of liquid and solid metals. The ratio of the resistivities of the liquid metal to that of the solid metal at the melting point has also been calculated. Good agreement obtained for Li, Na, K. P. T. LANDSBER

537.311.3

4349. On θ values in the resistance of metal P. G. KLEMENS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 71–2 (*Jan.*, 1952).

It is pointed out why the Debye temperature derived from the low-temperature specific heat an always less than θ_L (calculated from the specific hea due to interaction between longitudinal phonons an electrons), often agrees with θ_R (obtained fro measurements of electrical resistance at high and lo temperatures). C. A. HOGARTH

537.311.33

4350. The temperature-dependence of the dark conductivity of cadmium sulphide. K. W. BÖER *Ann. Phys.* [*Lpz.*], **10**, 20–31 (*No.* 1–2, 1952) *I German.*

Experiments on the conductivity of CdS crystal as functions of temperature and time were carried out. The results for measurements up to 600°K indicate impurity levels lying 1·5 eV or thereabouts below the conduction band. Specimens given a previous heat treatment to higher temperatures yield activation energies in three ranges, approximately 0·9 to 1·1, 0·5 to 0·7 and 0·1 to 0·35 eV. Creep effects were observed when currents through the specimens were measured as functions of time. Some influence on the conductivity by the surrounding gas, e.g. N_2, was observed. C. A. HOGARTH

537.311.33

4351. The influence of temperature-dependent Fermi levels on the conductivity of semiconductors. K. W. BÖER. *Ann. Phys.* [*Lpz.*] **10**, 32–47 (*No.* 1–2, 1952) *In German.*

Theoretical expressions for the shift of Fermi level with temperature are derived and applied to the explanation of results of measurements on CdS (preceding abstract). The case where the impurity levels occupy several discrete ranges between the full and conduction bands is considered in detail. C. A. HOGARTH

537.311.33

4352. Properties of films of non-metallic antimony. T. S. MOSS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 147–8 (*Feb.*, 1952).

Semiconducting layers of Sb were obtained by evaporating *in vacuo* on to substrates cooled to 195°K or 90°K. The layers changed irreversibly to the metallic form near 0°C. Activation energies from resistance *v.* temperature curves were 0·07 eV at high and 0·11 eV at lower temperatures. The resistance of the layers decreased on irradiation at least out to 15 μ, the maximum sensitivity being in the 4–9 μ region. There was no well-defined drop in sensitivity at long wavelengths and it could not be ascertained whether the effect was photoconductive or bolometric. Response times were about 10^{-3} sec. C. A. HOGARTH

537.311.33

4353. Resistivity of evaporated tellurium films. T. SAKURAI AND S. MUNESUE. Letter in *Phys. Rev.*, **85**, 921 (*March* 1, 1952).

Resistance *v.* temperature curves show that the

properties are similar to Ge films in that deposition on cold substrates produces amorphous layers, whereas deposition on to substrates at 200°C produces crystalline films which behave more like bulk Te.

C. A. HOGARTH

537.311.33

4354. Zinc as an acceptor in germanium. W. C. DUNLAP, JR. Letter in *Phys. Rev.*, **85**, 945 (*March* 1, 1952).

Experiments in which Zn is added to Ge as a trace impurity in single crystals, and in which Zn is made to diffuse into Ge and produce *p–n* junctions, suggest that Zn can act as an ionized acceptor. The activation energy in the impurity range is 0·031 eV for Zn-doped Ge, the same value as for *p*-type Ge produced by thermal shock.

C. A. HOGARTH

537.311.33 : 621.326 : 621.314.6

4355. The effect of gas pressure in the electric bulb on the polarity of the rectified current. S.-Y. CH'EN AND W.-C. LI. *J. Appl. Phys.*, **23**, 228–33 (*Feb.*, 1952).

In sequel to the experiment by Ch'en and Liu [*Chin. J. Phys.*, **7**, 192–205 (*June*, 1948); Abstr. 335 B (1949)] that a rectified current was derivable from the surface of the bulb when the bulb was coated with Chinese ink and was run by alternating current, the following points were observed with 220 V bulbs: (1) When the nitrogen pressure inside the bulb was more than a hundred mm Hg, the polarity of the rectified current was always negative, and the current amounted to a few milliamperes. The current decreased with the decrease of pressure. At a pressure of a few mm Hg the current was decreased to a very small value, and then turned to positive polarity when the pressure was further decreased. The positive current increased to a weak maximum at a few tenths of a mm Hg and came down again as the pressure was further lowered. (2) The current *v.* pressure curves for argon, helium and neon were essentially similar to those for nitrogen. (3) When the inner surface of the bulb was coated with a layer of metallic sodium, the rectified current, which was positive while without the coating, turned out to be negative. (4) When the material used to paint the bulb contained no sodium compounds, a quick fatigue was observed.

A.

537.311.33

4356. Some further observations on the effect of bending on selenium rectifier discs. P. SELÉNYI. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 161–2 (*Feb.*, 1952).

Additional experimental data are given to those previously reported [Abstr. 2891 (1952)] and it is shown how a selenium rectifier disk can act as a convertor of mechanical or audio impulses into corresponding alternating currents.

C. A. HOGARTH

537.311.33

4357. Measurement of the d.c. resistance of selenium and copper oxide rectifiers below room temperature. D. M. GRIMES AND S. LEGVOLD. *J. Appl. Phys.*, **23**, 312–16 (*March*, 1952).

Values of the steady-state d.c. resistance of copper oxide and selenium rectifiers as a function of temperature from 79°K to 300°K were obtained. The maximum potentials used were 2·5 V in the forward direction and 6·0 V in the backward direction. It was found that a plot of the logarithm of the resistance against the reciprocal of the temperature was nearly linear for all except the reverse direction of the selenium rectifier. For the latter case at 6·0 V the resistance went through a minimum below 200°K.

A.

537.312.5

4358. Photoconductivity in vacuum coated selenium films. P. H. KECK. *J. Opt. Soc. Amer.*, **42**, 221–5 (*April*, 1952).

Photoconductive layers which have a dark resistivity higher than 10^{12} ohm×cm, are of particular interest for electrophotography and television pick-up tubes. Se coatings prepared by vacuum evaporation are suited for these purposes. At base plate temperatures lower than 50°C, vitreous Se is deposited which shows photoconductivity for wavelengths shorter than 600 millimicrons. At higher coating temperatures, many small hexagonal Se crystals embedded in the vitreous matrix are introduced. Both the nucleation and velocity of crystal growth are investigated. A small percentage of crystalline Se produces an additional red sensitivity, while high dark insulation qualities are preserved. The incident light causes positive holes from the hexagonal crystals to be injected into the vitreous Se. A small addition of Te induces at low coating temperatures a shift of the photosensitivity towards longer wavelengths. At higher temperatures coatings with fairly panchromatic response can be produced.

A.

537.312.5

4359. Note on quenching of photoconductivity in cadmium sulfide. E. A. TAFT AND M. H. HEBB. *J. Opt. Soc. Amer.*, **42**, 249–51 (*April*, 1952).

The spectral distribution of quenching of the photoconductivity in CdS crystals has been investigated. The process is interpreted as excitation of trapped holes by the quenching radiation, followed by thermal ionization to the filled band. Freeing of trapped electrons does not appear important. Two peaks in the quenching spectrum occur at $h\nu = 1{\cdot}5$ and $0{\cdot}9$ eV and are attributed to different hole traps. Transient changes in photoconductivity on application or removal of radiation in the red are shown to arise from simultaneous excitation and quenching processes with different time dependences. As a consequence, the quenching spectrum can be followed for some distance into the excitation region and vice versa.

A.

537.312.5 : 548.5

Oxygen-free single crystals of lead telluride, selenide, and sulfide. *See Abstr.* 4738

537.312.6 : 537.32

4360. Some properties of Ni–Mn alloys of intermediate composition. I. T. SATO. *J. Phys. Soc. Japan*, **6**, 223–7 (*July–Aug.*, 1951).

Measurements were made on both annealed and quenched specimens of the variation with temperature T both of the electrical resistance R of alloys of 47 and of 50 at. % Mn, and of the thermoelectric power against Pt of 47 at. % alloys. Results are presented graphically. The difference in R at room temperature between quenched and annealed speci-

mens is very small for 47 at. % alloys, but for 50 at. % R (quenched) $\simeq 1{\cdot}8$ R (annealed). Since no evidence could be found of any superlattice formation, the possibilities are discussed that this result may be due to the formation of a Ni–Mn compound or that it is connected with the effects of quenching upon the electronic structure. All specimens show a large and negative temperature coefficient of resistance and an anomalous behaviour in the thermoelectric power in the T range ~500–700°C. This is thought to be due to some electronic feature of the α–β Mn transformation ($T_T \sim 700$°C) still remaining in the alloys of Mn with Ni, although these themselves show no structural changes in the temperature range studied. A. D. LE CLAIRE

537.312.62

4361. Adiabatic magnetization of superconductors. K. MENDELSSOHN. Letter in *Nature* [*Lond.*] **169,** 366 (*March* 1, 1952).

A general expression is given for the cooling obtainable by the destruction of superconductivity in a magnetic field. In the region between 0·3°K and 1°K this method has certain advantages over the demagnetization of paramagnetic salts. H. LONDON

537.312.62

4362. Experiments with audiofrequencies on superconductors. B. SERIN AND C. A. REYNOLDS. Letter in *Phys. Rev.*, **85,** 938 (*March* 1, 1952).

Evidence supplementary to Abstr. 1808 (1952) is given in answering the criticism by Galkin and Bezuglyi [Abstr. 9488 (1951)]. H. LONDON

537.312.62 : 538.23

4363. Magnetic hysteresis in superconducting colloids. A. B. PIPPARD. *Phil. Mag.*, **43,** 273–84 (*March*, 1952).

The irreversible effects exhibited in the magnetization cycle of a superconducting colloid are analysed in terms of a simple model of a superconductor. Expressions are derived relating various critical field strengths to temperature and radius of the particle; there is fair agreement between experiment and theory. A.

537.315 : 621.3.015.1

4364. The peripheral potential drop of an e.m.f. inside a conducting medium. A. GEMANT AND E. B. MILLER. *Amer. J. Phys.*, **20,** 227–30 (*April*, 1952).

When an e.m.f. embedded in an electrically conducting medium, is measured by peripherally applied probe electrodes, the ratio of the measured potential drop to the total e.m.f. must be known. It is shown how this ratio can be obtained by computation. The specific case of an electromagnetic blood-flow meter is used as the basis of computation. A.

537.32 : 538.63/.65

4365. On the magneto-thermoelectric power of iron crystal at high temperature. Z. FUNATOGAWA. *J. Phys. Soc. Japan*, **6,** 256–60 (*July–Aug.*, 1951).

Previous experiments on the magnetization dependence of the thermoelectric power were extended to higher temperatures [Abstr. 1854 (1951)]. It was found that E_{100} (the change between remanence and saturation along the [100] direction) decreases almost linearly with increasing temperature, while E remains constant up to about 200°C and the decreases, both tending to zero at the Curie point. The relation with the temperature variation of the magnetostriction coefficients is shown. E. P. WOHLFARTH

537.36

4366. Separation of ions in ion exchange columns by ionophoresis. G. MANECKE. Note in *Naturwissenschaften*, **39,** 62–3 (*No.* 3, 1952) *In German.*

Ions can be separated in a tube by an electric field according to their various mobilities. Complete separation is attained in a horizontal column with a length of 8 cm and a voltage difference between the electrodes of 120 V, when ion exchangers are added. A. J. TAYLOR

537.363 : 541.182.2

4367. Electrophoresis in nonaqueous media. M. HAYEK. *J. Phys. Coll. Chem.*, **55,** 1527–33 (*Dec.* 1951).

A microelectrophoresis cell was constructed and technique developed for the measurement of mobilities of suspended particles in non-conducting media in the presence or absence of dispersing agents. Variable and non-uniform charges on particles in such systems were observed. Particles in non-conducting media may be charged, but the charges are incidental to, not responsible for, the stability of the sols. A.

ELECTRIC DISCHARGES 537.52

537.52 : 533.7

4368. The mathematical theory of electrical discharges in gases. T. KIHARA. *Rev. Mod. Phys.*, **24,** 45–61 (*Jan.*, 1952).

The Boltzmann theory treatment of electrical discharges in gases has been one of the undeveloped fields in physics. The aim of this paper is to show what type of molecular model makes the mathematical treatment of the problem possible. The fundamental processes of the molecular kinetic theory of electrical discharges concern the collisions between gas molecules and charged particles such as ions or electrons. The effective cross-sections of the molecule for elastic, exciting and ionizing collisions are the fundamental quantities regarding these phenomena. Two methods are considered, according to how these fundamental quantities are introduced, to establish the molecular kinetic theory. One method is to adopt a proper molecular model for collision processes. The other method is to adopt the "exact" (i.e. observed or quantum-mechanically calculated) values of collision cross-sections. This paper concerns itself with the first method, and the principal objective is to attain mathematical simplicity for the theory. The second method is abandoned because the statistical calculation on each step is complicated, and furthermore, the calculation must be achieved separately for each kind of gas. This second method may be adequately adopted after the treatment based on a model is accomplished. A.

537.521 : 537.562

4369. The diffusion theory of discharge plasmas. R. SEELIGER. *Naturwissenschaften*, **39**, 78–81 (*No.* 4, 952) *In German.*

A review, with 16 references, of work on diffusion processes in plasmas including such effects as the self-field, etc. J. D. CRAGGS

537.521.7 : 539.17

4370. An attempt to produce a thermo-nuclear reaction in deuterium by means of a high current spark discharge. P. R. REYNOLDS AND J. D. CRAGGS. Letter in *Phil. Mag.*, **43**, 258–60 (*Feb.*, 1952).

It was hoped that the self-magnetic field of the 85 kA current would produce a constriction of the spark channel which would increase the temperature and ionization of the deuterium gas sufficiently to produce $H^2 + H^2 \rightarrow He^3 + n'$. No neutrons could be detected, showing that the temperature did not reach 10⁶°C. W. J. SWIATECKI

537.523

4371. Striations in the hydrogen glow discharge. V. A. GAMBLING. Letter in *Phys. Rev.*, **85**, 677 (*Feb.* 15, 1952).

Briefly discusses Fowler's observations [Abstr. 309 (1952)] on the distortion of striations in glow discharge tubes with a side tubulation. J. D. CRAGGS

537.523.3

4372. Mechanisms of positive and negative corona in hydrogen and argon between coaxial cylindrical electrodes over an extended pressure range. E. J. LAUER. *J. Appl. Phys.*, **23**, 300–7 (*March*, 1952).

Mechanisms in the corona discharge from a fine Pt wire at a positive potential along the axis of a hollow Ni cylinder were investigated by using the oscilloscope to analyse the pulses caused by α-particles passed through the low-field region parallel to the wire. γ_p the secondary coefficient for the photoelectric effect at the cathode in H had values from 70×10^{-5} at 100 mm to 5×10^{-5} at 650 mm pressure. γ_i for the H ions at the cathode was less than 10^{-6}. The mobility of the positive ions (presumably H_3^+) was 3·4 (± 0·4) cm²/volt×sec at 760 mm and 20°C. Adding 0·1 to 1·0% O to H resulted in the formation of O_2^- ions. γ_i for the argon positive ions was about 1×10^{-4} extrapolated to zero pressure and decreased with increasing pressure and γ_p was less than $\frac{1}{10}\gamma_i$. Most of the ions were A_2^+ with a mobility of 1·94 (± 0·08) cm²/volt×sec. Positive-wire d.c. current voltage data were taken in H and A at several pressures. Sparks occurred with the positive wire in A at relatively lower gap voltages than in H. Current-voltage data were taken with the wire negative. In H the discharge started as a small (10^{-11} amp.) self-supporting current (probably uniformly distributed along the wire) which changed with increasing gap voltage to a larger (microampere) discharge localized in luminous spots on the wire in analogy to Miller's observations in N. No small self-supporting currents were observed in A. The discharge started as a spark above 200 mm and as a glow that spread uniformly over the wire below 100 mm pressure. A.

537.523.4 : 537.523.74

4373. Theoretical and experimental researches on the excitation of gases at ultra-high frequencies. M. BAYET. *Rev. Sci.* [*Paris*] **89**, 351–94 (*Nov.–Dec.*, 1951) *In French.*

This detailed paper contains sections on a general elementary study of drift in a continuous electric field, breakdown mechanisms in alternating fields, including u.h.f. fields, and a survey of de-ionization mechanisms (recombination, diffusion and the effect of electron attachment). There is also a discussion of exptl. results on u.h.f. breakdown in gases. Exptl. data on the light emission from sparks, and afterglows following sparks, are then given. The bibliography includes 79 references. J. D. CRAGGS

537.525 : 537.534

4374. Positive ions in the afterglow of a low pressure helium discharge. A. V. PHELPS AND S. C. BROWN. *Phys. Rev.*, **86**, 102–5 (*April* 1, 1952).

The production and loss of He^+ and He_2^+ ions in the afterglow of a low pressure helium discharge are studied, using a mass spectrometer to analyse the positive ions and microwave techniques to determine the electron density. The change of positive ion and electron density with time is explained by considering three dominant processes in the afterglow: the production of He^+ ions and electrons by collisions between pairs of metastable atoms, the ambipolar diffusion of the ions and electrons, and the conversion of He^+ ions to He_2^+ ions by three-body collisions with neutral atoms. The time constants for the decay of the electron density at low pressures yield the ambipolar diffusion coefficient for He^+ ions of 560 cm²/sec and a frequency for the conversion of He^+ ions into He_2^+ ions of 65 sec^{-1}, both at 1 mm pressure and 300°K. The mobility coefficient for He^+ ions in helium obtained from the measured ambipolar diffusion coefficient is 14 cm²/volt-sec at 300°K and 760-mm pressure and agrees satisfactorily with the value of 12 cm²/volt-sec calculated using the quantum mechanical interaction of the He^+ ion and the neutral helium atom. A.

537.525.3 : 537.525.72 : 537.525.8

4375. Production of the Joshi effect under β- and γ-rays. V. G. BHIDE, M. R. BHIDAY AND G. V. ASOLKAR. Letter in *Nature* [*Lond.*] **169**, 542–3 [*March* 29, 1952].

Describes how the discharge current in an a.c. operated ozonizer tube can be altered by external irradiation (Joshi effect) using β- and γ-rays. J. D. CRAGGS

537.525.5 : 536.24 : 621.314.65.032.212

4376. Pool surface and cathode spot temperature of mercury cathodes as a problem in heat conduction. H. v. BERTELE. *Brit. J. Appl. Phys.*, **3**, 127–32 (*April*, 1952).

The normal equilibrium of metal molecules and electron temperature is disturbed in the cathode spot. The heat transfer through the cathode pool is merely a matter of the molecular temperature. Thus the metal temperature depends upon the share which the heat conductivity through the pool takes in the total heat dissipation occurring in the discharge device in question. A particular transfer rate is only a convenient technical characteristic for individual arrangements, but no definite physical datum. Discrimination has to be made between the temperature of the metal

surface at the actual spot position and that at the neutral parts. The average of the latter is mainly dependent on the actual cathode current, while the temperature in the spot is a variable feature following the fluctuations accompanying the spot phenomenon, such as current subdivision in several spots, change of spot current, and momentary spot migration speed. Calculation of the thermal fields of moving spots yields about 240°c temperature rise for an average spot size of 6·7 Å and a range of at least 80°–400°c when considering the possible variations of spot current. The thermal potential around each spot shows a strong gradient at the spot boundary. Most of the temperature rise occurs within three times the spot radius (0·03–0·1 cm). A.

537.525.5 : 537.525.8 : 537.542

4377. A study of helium gas clean-up in an electric arc discharge. M. J. REDDAN AND G. F. ROUSE. *Elect. Engng, N.Y.*, **71**, 159–64 (*Feb.*, 1952).

The paper gives a brief review of clean-up of rare gases which leads to the belief that the cleaned up gas may disappear by being driven as positive ions into a negatively charged electrode from which recovery, perhaps by heating, of the gas is possible. A detailed description of experimental tubes for the study of clean-up of pumped He is given. The results support the above mechanism, but the recovery of gas, by heating or sputtering, from the electrode absorber was incomplete. Thus the explanation of the clean-up is not full or final. J. D. CRAGGS

537.525.5 : 538.566

4378. Behavior of gas discharge plasma in high-frequency electromagnetic fields. L. GOLDSTEIN AND N. L. COHEN. *Elect. Commun.*, **28**, 305–21 (*Dec.*, 1951).

Describes various expts. on the u.h.f. properties of low-pressure gaseous discharges. In the first expts. the discharge tube was inserted in a coaxial line and the properties of the discharge, in various gases, e.g. the attenuation due to it, found at varying currents and pressures. Electron densities were thus estimated. Expts. on noise in discharges, at 2000 Mc/s, were also carried out and are described. Finally, an account of expts. on pulsed discharges and their "afterglows" is given. J. D. CRAGGS

537.529

4379. On the noise of pre-breakdown current [in solids]. H. KAWAMURA AND M. ONUKI. Note in *J. Phys. Soc. Japan*, **6**, 283–4 (*July–Aug.*, 1951.

Gives data on pre-breakdown noise in mica for frequencies varying from 28–600 kc/s. Assuming that the noise is due to avalanche processes, the average avalanche size could be estimated. Noise was detected at a voltage of 40% × (breakdown value). J. D. CRAGGS

X-RAYS 537.531

537.531 : 535.313

4380. Grazing-incidence reflecting systems for optical imaging by X-rays. H. WOLTER. *Ann. Phys.* [*Lpz.*] **10**, 94–114 (*No.* 1–2, 1952) *In German.*

With two mirrors, a hyperboloid and a paraboloid arranged coaxially, an image can be formed by ra twice reflected at grazing incidence, and the Ab sine condition is approximately fulfilled. The aber tions are discussed, and it is shown that a numeri aperture of 0·05 is practicable for X-rays of wa length 24 Å. This wavelength is suitable for t study of living biological specimens because it absorbed strongly by carbon and nitrogen, but n by water. A proposed vacuum microscope is describe Systems of more than two mirrors are also discusse A. R. STOK

537.531 : 535.33.

4381. A spectrometer for an investigation of angul dependence of the structure in the continuous X-ra spectrum. P. OHLIN. *Ark. Fys.*, **4**, 387–90 (*Paper* 2 1952).

A spectrometer using a bent quartz crystal and Geiger counter is described. The fine structure ne the limit of the continuous spectrum (P. Ohlin, *Ar Mat., Astr. Fys.*, 29*A* (*No.* 3, 1942) is shown to va with the angle between the X-ray beam and t electron beam in the X-ray tube. A. R. STOK

537.531 : 535.33.

4382. On the focusing conditions for double-cryst X-ray spectrometers. R. C. SPENCER. Letter *Rev. Sci. Instrum.*, **23**, 138–9 (*March*, 1952).

Considers the small-angle scattering of mono chromatic X-rays and the X-ray spectroscopy heterochromatic radiation, and points out the analog between the two. The discussion relates to the us of Geiger counters and in each case deals with (*a*) focus moving with the second crystal and (*b*) a fixe focus. J. THEWL

537.531 : 537.54

4383. Quantitative measurements of low dose-rat roentgen rays in terms of the international *r*-unit b closed ionization chambers. R. THORÆUS. *Ark. Fys.* **4**, 353–61 (*Paper* 18, 1952).

The use of condenser ionization chambers fo measurements of X-rays at low dose rates is described For two such chambers the variation of sensitivit with direction, and with radiation quality is discussed together with their applications in radiological work H. MILLE

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

4384. On the wave mechanical theory of electron optical image formation. W. GLASER. *S.B. Öst. Akad. Wiss., IIa*, **159**, 297–360 (*No.* 9–10, 1950) *In German.*

The material in this paper was presented in a se of lectures at the German University of Prague in 1942/43. The treatment of geometrical electron optics as a limiting case of wave mechanics. The calculation of wave surfaces up to the third order, in an axially symmetric field, is carried out. The Schrödinge equation is solved for a "Seidel" electron beam. The

electron density in the image plane is determined, and representations of wave functions are given.

L. S. GODDARD

537.533.72

4385. A simple procedure for determining the field in magnetic electron lenses. F. LENZ. *Optik*, **9**, 3–18 (*No.* 1, 1952) *In German.*

A method of determining the field by means of a probe electron beam is described, with full mathematical details. The objective diaphragm is removed and the voltage for a sharp point focus with a diffuse halo is measured for several values of the lens current. This corresponds with "telescopic" ray paths, i.e. paraxial paths which are parallel at entry are parallel at exit. A. H. W. BECK

537.533.72 , 537.534.72

4386. Velocity-dependent potentials for particles moving in given orbits. M. L. COFFMAN. *Amer. J. Phys.*, **20**, 195–9 (*April*, 1952).

Velocity-dependent potential functions can sometimes be used to determine the field of force that can be applied in order that particles may move in specified paths. In particular, the electromagnetic field vectors **E** and **B** can be determined from such a potential function if the paths on which charged particles move are specified. The velocity-dependent potential U is related to the kinetic energy T and the Lagrangian function L by the equation $U = T - L$, where L is an arbitrary solution of the Lagrange equation $(d/dt)(\partial L/\partial p') - (\partial L/\partial p) = 0$, where $p =$ constant represents the orthogonal trajectories of the curves which describe the paths the particles are to follow. From the velocity-dependent potential function U, the field of force can be calculated by the definition $Q_p = -(\partial U/\partial p) + (d/dt)(\partial U/\partial p')$. A.

537.533.72

4387. A note on the study of the phenomenon of axial focusing in [axially symmetric] magnetic spectrographs having a plane of symmetry. J. LAFOUCRIÈRE. *C.R. Acad. Sci.* [*Paris*] **234**, 936–8 (*Feb.* 25, 1952) *In French.*

If the ray having $r = r_0 = H\rho/H_z$ is taken as the unperturbed ray, the first-order radial and axial perturbation functions become imaginary if $n > 1$, $n < 0$ respectively, where $H_z \propto r^{-n}$ at $r \simeq r_0$. It is pointed out that if either function is imaginary, the real one has no physical importance. Preliminary notice is given of a new theoretical treatment valid for all n. J. C. E. JENNINGS

537.533.72

4388. Focusing in a beta-ray spectrometer with tilted sources. C. M. FOWLER AND P. DOMOTOR. *J. Appl. Phys.*, **23**, 415–17 (*April*, 1952).

Formulae are given which express the theoretical line shape obtained in a semicircular beta-ray spectrometer. The sources are taken to be plane, uniform and isotropic. Line shapes of a monoenergetic electron group are studied as a function of the angle between source and focal planes. The treatment given applies only to the electrons emerging perpendicular to the magnetic field. However, conditions simulating the requirements for qualitative applicability of the formulae may be obtained practically by slitting out electrons having appreciable momentum components along the field. Two figures illustrate line shapes for various spectrometer geometries. A.

537.533.72

4389. A solenoidal spectrometer for the undergraduate laboratory. B. T. WRIGHT. *Amer. J. Phys.*, **20**, 236–42 (*April*, 1952).

This instrument has several features which make it especially adaptable to use in an undergraduate laboratory. One is that the coil geometry is such that the student may readily verify that the range of variation of the magnetic field on the principal axis is less than ¼%. Secondly, the baffle geometry is of sufficient simplicity to enable the better student to calculate not only the momentum admitted by the baffle system, but as well to predict the line shape for a monoenergetic source, and thus to obtain the theoretical resolution of the instrument. Thirdly, as a result of the first mentioned features, the instrument is absolute. Construction details are included. For the instrument described, the absolute accuracy is better than 0·4%, the resolution is 1·9%, and the useful solid angle is 0·8%. A.

537.533.74

4390. On the radiative correction to the Coulomb scattering of electrons. L. R. B. ELTON AND H. H. ROBERTSON. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 145–6 (*Feb.*, 1952).

Schwinger's treatment [Abstr. 1511 (1950)] of the infra-red divergence in the radiative correction to electron scattering and in the related bremsstrahlung is clarified by the discussion of two compensating errors in his calculation. For several energies below 10 MeV, the radiative corrections to essentially elastic scattering (energy loss $< \Delta E$) by light nuclei are tabulated as function of θ and of ΔE. R. H. DALITZ

537.533.74

4391. High energy electron-electron scattering. W. H. BARKAS, R. W. DEUTSCH, F. C. GILBERT AND C. E. VIOLET. *Phys. Rev.*, **86**, 59–63 (*April* 1, 1952).

Eradicated electron sensitive nuclear emulsions were exposed to 200 MeV electrons at the Berkeley synchrotron. In scanning the electron tracks 427 events were observed in which the scattered electron of lower energy, or knock-on electron, had an energy greater than 30 keV. The observed differential cross-section was found to agree in absolute value with Møller's theoretical cross-section, although an insufficient number of high energy knock-on electrons were observed to distinguish between the Møller, relativistic Mott, and relativistic Rutherford formulae. Two pairs initiated by primary electrons and two cases in which primary electrons vanished in the emulsion were also observed in 102·6 cm of track. No heavy particle events were seen. A.

537.533.74 : 537.534.74

4392. Electronic and ionic impact phenomena. H. S. W. MASSEY AND E. H. S. BURHOP. (International Series of Monographs on Physics.) *London, Oxford University Press* (1952) 688 *pp.*

"This work gives a comprehensive account of most aspects of impact phenomena for collisions of particles of low energy (less than 100 keV), dealing in particular with the collision of electrons, positive ions and neutral atoms with atomic systems, molecules and

surfaces, and discussing the importance of such collision phenomena in the elucidation of many different branches of physics. It is written primarily from the experimental and descriptive point of view and forms a companion book to Mott and Massey's *Theory of Atomic Collisions*. Sufficient of the theory is given in the present book, however, to enable it to be read without reference to other works."

537.533.75 : 539.165

4393. Range-energy relations for electrons and the determination of beta-ray end-point energies by absorption. L. KATZ AND A. S. PENFOLD. *Rev. Mod. Phys.*, **24**, 28–44 (*Jan.*, 1952).

It is shown that for Al absorbers, a single range-energy equation $R = 412\,E_0^{1.265-0.0954\ln E_0}$ (mg/cm²) will fit the most reliable published values of practical ranges of monoenergetic electrons and the maximum ranges of nuclear β-rays in the energy region $0{\cdot}01 \leqslant E_0 \leqslant 2{\cdot}5$ MeV. The average deviation of 59 monoenergetic measurements from this equation is $+0{\cdot}08\%$ in energy, and $-0{\cdot}05\%$ in energy for 35 β-ray measurements. The mean deviation is 4·1% in each case. There are few ranges for energies above 2·5 MeV. All the higher energy values found in the literature and 4 new measurements on monoenergetic electrons are presented and are shown to be consistent with the range-energy equation $R = 530\,E_0 - 106$ (mg/cm²) for $E_0 \geqslant 2{\cdot}5$ MeV. It is shown that the curve (dE_0/dR) is nearly parallel to the theoretical curve for the rate of energy loss by ionization in the region between 0·01 and 20 MeV and is about 25% larger. The reason for this discrepancy is not known. All the methods commonly used to determine the ranges of β-rays from absorption curves are discussed and a new method developed by the authors is presented. A.

537.533.8

4394. Theoretical contributions to the study of the Cherenkov effect. A. BATTIG. *Univ. Nac. Tucumán Publ. No.* 591 (*Inst. Fis. Publ. No.* 3*c*) 69 *pp.* (1951) *In Spanish.*

The various (classical and quantum) theories of the effect are reviewed and compared. The method of images is particularly treated and applied to the problem of the transition of the Cherenkov cone from a medium to another of lower dielectric constant.

L. PINCHERLE

537.533.8

4395. The theory of ionisation and the emission of Cerenkov radiation. M. SCHÖNBERG. Letter in *Nuovo Cim.*, **9**, 210–11 (*Feb.*, 1952).

A quantum treatment of the emission of Cherenkov radiation is needed, since close collisions are important and since the energy of the most intense Cherenkov bands is about a typical ionization potential. Experimentally, the ionization loss of relativistic particles appears to exceed the present theoretical result in which polarization effects are calculated classically.

R. H. DALITZ

537.534 : 621.384.61

4396. A fixed-frequency cyclotron with 225-cm pole diameter. H. ATTERLING AND G. LINDSTRÖM. *Nature* [*Lond.*] **169**, 432–4 (*March* 15, 1952).

In this machine, at the Nobel Institute for Physics, Stockholm, deuterons are accelerated to an energy of 25 MeV at a radius of 90 cm. The necessary field of 11 500 oersteds is produced in a 33 cm gap between the pole faces of a 400-ton magnet with a power input of about 60 kW. The dees are operated at 200 kV and a frequency of 8·7 Mc/s. A particular feature of this cyclotron is that the dee stems are insulated from earth by means of water-cooled plate condensers which act as short circuits to the r.f. current but permit the use of a fixed bias of 500–700 V on the dees. This has proved sufficient to prevent discharges in the accelerating chamber. An internal target is employed. The cyclotron is housed in an underground hall with the control room and auxiliary equipment in a building above. L. R. SHEPHERD

537.534 : 621.384.6

4397. The University of Birmingham cyclotron. *Nature* [*Lond.*] **169**, 476–7 (*March* 22, 1952).

The cyclotron is adjusted to accelerate deuterons to 20 MeV, giving 40–70 μA in an external beam with an energy spread of 1 MeV. An analysed beam of 4 μA with 0·15 MeV spread is also obtained. A 250-ton magnet is employed and under present operating conditions a field of 13 500 oersteds is produced in a 12 in gap with 40 kW power dissipation, the magnet current being held stable to 0·01%. The dees operate at 150 keV with a fixed frequency of 10·24 Mc/s. The dee stems form the inner conductors of coaxial lines, shorted at the outer ends. Two 14 in oil diffusion pumps maintain a pressure of 2×10^{-5} mm under normal operating conditions. A hooded arc-type ion source consuming 0·35 ml of D per hour is used. The external beam is extracted through a 50 μ Al window. The machine is also used for accelerating H_2^+ ions (giving 10 MeV protons) and He^{++} ions (40 MeV α-particles). A fast neutron flux of 10^8 n/cm²/sec is obtained in the forward direction at 1 m from a Be target bombarded with 30 μA of 20 MeV deuterons. L. R. SHEPHERD

537.534

4398. Application of the W.B.K. method to the dynamics of linear accelerator. M. HOYAUX. *Rev. Sci. Instrum.*, **23**, 173–5 (*April*, 1952).

The dynamics of "small motions" in a linear accelerator is studied in as general conditions as possible. It is concluded that heavy particles cannot be accelerated up to the BeV range by any practical combination of Tm and/or Te travelling and/or stationary waves. Several methods are however possible for electrons. In the case of heavy particles, charges or currents must be introduced inside the beam. Two methods seem promising (*a*) the Berkeley device (foils or grids) in which the beam expands as the power $(\frac{1}{3})$ of energy, and (*b*) a coaxial structure with d.c. bias ($\simeq$100 kV) in which the beam radius remains approximately constant. The focusing by means of a d.c. current parallel to that of the beam is not practical. A.

537.534

4399. The million-volt H.T. accelerator at the Cavendish Laboratory, Cambridge. J. V. JELLEY. *Atomics* [*Lond.*] **3**, 61–6, 84 (*March*, 1952).

The 1 million-volt Phillips high-tension generator

has been in operation at the Cavendish Laboratory since 1936. The high voltage is generated by means of a 220 kV transformer, with a cascade of voltage multipliers consisting of 12 high tension rectifiers and 12 condensors. The design of the generator, ion source, accelerator tube and other auxiliary equipment is outlined. Some of the uses of the machine are described briefly. L. R. SHEPHERD

537.534 : 621.384.62

4400. A 1·5 MV accelerator for heavy particles with analyzing magnet for use in nuclear research. C. MILEIKOWSKY AND R. T. PAULI. *Ark. Fys.*, **4**, 287–98 (*Paper* 12, 1951).

The h.t. set of the Nobel Institute in Stockholm is described in detail. It consists of a 7-stage cascade generator, using a 500 c/s supply voltage to reduce ripple. A 20 Mc/s r.f. ion source is used, giving a focused proton current of 100 μA up to 800 keV. Protons, H_2^+ or H_3^+, are selected at will by a large deflector magnet, enabling a well-focused beam to be obtained down to an effective proton energy of 66 keV. The maximum voltage so far used is 1·1 MV.

J. H. FREMLIN

537.534

4401. A new method of measuring the ion current of mass spectrometers. I. NONAKA., S. HIRASAWA AND K. TSUTSUMI. *J. Phys. Soc. Japan*, **6**, 466–72 (*Nov.–Dec.*, 1951).

In most mass spectrometers the ion current received by the collector is measured by d.c. amplifiers, but it is preferable to use a.c. amplifiers, if possible, because there is no zero drift and the number of stages can be easily increased. This was done with a mass spectrometer of Nier type. The ion current was made alternating by giving the potential of the first slit a rectangular form of -4 volts and $+1$ volt relative to the ion source chamber. The ion current amplified by a three-stage a.c. amplifier of 110 db was rectified and then measured by a d.c. milliammeter of 1 mA full scale. The amplifier was very stable and the current amplification factor was about $0{\cdot}7\times10^{10}$, the minimum ion current detectable at the collector being about $1{\cdot}5\times10^{-15}$ A. A.

537.534 : 621.384.6 : 621.311.6

4402. A radio-frequency power supply system for high voltage accelerators. P. A. DAVENPORT. *Brit. J. Appl. Phys.*, **3**, 124–6 (*April*, 1952).

A multi-channel link for r.f. power is provided between the ground and the high-voltage terminal, each separate power requirement of the ion source assembly having its own channel. Oscillators at ground potential provide the power, and adjustment of their outputs gives positive control of the beam intensity and focus. A.

537.534.72

4403. On the form of pole pieces used in new spiral orbit spectrometer. M. SAKAI AND Y. NOGAMI. Note in *J. Phys. Soc. Japan*, **6**, 409–10 (*Sept.–Oct.*, 1951).

A pair of pole-pieces with constant gap near the centre, changing with a sharp step into conical shape (increasing gap) at a certain radius, produces a field distribution advantageous for the spiral orbit mass spectrometer [Abstr. 1100 (1951)] which promises well as an isotope separator. T. G. PICKAVANCE

537.534.72

4404. The focusing principles of high energy particle accelerators. III. High frequency linear accelerators. M. HOYAUX. *Atomics* [*Lond.*] **3**, 33–40, 52 (*Feb.*, 1952).

For Pt II, see Abstr. 3637 (1952). The phase and radial focusing properties of a number of different linear accelerators are analysed and compared. It is shown that in general simultaneous phase and radial focusing is not possible, although in some cases an external magnetic field can be used to control radial defocusing. A coaxial waveguide accelerator using a charged central wire for the same purpose, the "Belgatron," is described. J. H. FREMLIN

537.534.72

4405. A nuclear spectrometer for heavy particles. I. Design and construction of the instrument. C. MILEIKOWSKY. *Ark. Fys.*, **4**, 337–46 (*Paper* 16, 1952).

Descriptive data are given of a 180° deflection stigmatic focuser of the type of Snyder *et al.* [Abstr. 1115 (1951)]. It has an external yoke, conical-faced pole-pieces with an approx. 5 cm gap and two 45 000 amp-turns coils providing 18 000 gauss; the principal ray has a radius of 40 cm. Focusing properties are not discussed. J. C. E. JENNINGS

537.534.74

4406. Proton-proton scattering at 240 MeV by a magnetic deflection method. O. A. TOWLER, JR. *Phys. Rev.*, **85**, 1024–9 (*March* 15, 1952).

Differential cross-sections for proton–proton scattering were measured at 8 angles ranging from 171·3° to 108·1° centre-of-mass by magnetically deflecting protons scattered by hydrocarbon and C targets into photographic plates placed inside the tank of the Rochester 130 in cyclotron. The incident beam was monitored by the β-activity induced in the target by reaction $C^{12}(p, pn)C^{11}$, the absolute value of the cross-section being based on a 49 ± 3 mb C cross-section. The measured cross-section is isotropic within statistical errors from 108° to 167°, with an average value of $4{\cdot}66 \pm 0{\cdot}39$ millibarns/steradian, and increases sharply to a value of $15{\cdot}8 \pm 1{\cdot}6$ mb at 171·3°. The average value of the cross-section agrees with that of Oxley and Schamberger, but is in disagreement with the value obtained by Chamberlain, Segrè, and Wiegand. A.

537.534.74

4407. Nuclear elastic scattering of high energy protons. R. E. RICHARDSON, W. P. BALL, C. E. LEITH, JR AND B. J. MOYER. *Phys. Rev.*, **86**, 29–41 (*April* 1, 1952).

The differential elastic scattering cross-sections of C, Mg, Al, Si, S, Cu, Ag, Ta, W, Pb and Bi for 340 MeV protons are measured as a function of the angle of scattering. The source of the 340 MeV protons is the external scattered deflected proton beam of the Berkeley 184 in synchrocyclotron. The scattered protons are detected by a triple coincidence scintillation counter telescope whose detection threshold is set by Cu energy attenuators placed between the last two trans-stilbene scintillators. The observed angular distributions are similar to the

pattern observed in Fraunhofer diffraction of plane electromagnetic waves by an opaque disk. The details of the diffraction patterns indicate that the nuclei appear partially transparent to the 340 MeV protons. The observed patterns are found to be consistent with those predicted from elastic scattering of 83 MeV neutrons, indicating that the Coulomb forces are only important in changing the patterns at very small angles. An attempt is made to observe spin-dependent variations in the patterns from neighbouring nuclei whose moments are known to differ appreciably. Within the statistics and resolution of the experiment no appreciable variations are detected. A.

537.534.75 : 537.533.75

4408. The stopping power of a metal for charged particles. D. PINES. Letter in *Phys. Rev.*, **85**, 931 (*March* 1, 1952).

The energy lost by a fast charged particle to the conduction electrons in a metal, is expressed as the sum of the energy expended in the excitation of collective oscillations and that lost in short-range collisions with the individual electrons. J. A. FRANKS

537.534.75 : 778.3

4409. The stopping power of Ilford C_2 emulsion. A. J. DYER. *Aust. J. Sci. Res. A*, **5**, 104–13 (*March*, 1952).

The stopping power of Ilford C_2 nuclear emulsion under fixed water content conditions has been determined for protons in the energy range 1·73–5·26 MeV with an accuracy of 1%. The variation of stopping power with water content has been calculated and an appropriate correction applied. It has been found that the values obtained in this experiment are in substantial agreement with those of Lattes, Fowler and Cuer [Abstr. 3300 (1947)] and of Rotblat [Abstr. 6270 (1951)]. A consistency in stopping power of better than 0·3% has been observed between several batches. Some data on the straggling of protons in nuclear emulsion are presented. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 535.33.03

A new type of hydrogen discharge tube. *See Abstr.* 4216

537.542

4410. Photosensitive neon–argon discharge tubes in photometry. T. J. DILLON. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 236–8 (*March*, 1952).

Describes the use of light-sensitive discharge tubes in relaxation oscillator circuits and as quantitative detectors in photometry. J. D. CRAGGS

537.542

4411. The ion source of electron oscillation type. K. TSUKADA. Note in *J. Phys. Soc. Japan*, **6**, 415–16 (*Sept.–Oct.*, 1951).

A Philips ion gauge type of discharge is maintained by electrons accelerated from a hot filament by a ring anode (A). The geometry is cylindrical with axial magnetic field, and inner (grounded) and outer (~ -400 V) grids surrounded by a collecto (~ -400 V). The plasma is localized within th inner grid. In tests with hydrogen (2×10^{-3} mm Hg 10 mA of ions were received in a Faraday cup nea a slit in the collector, with energy spread ~ 30 V Other conditions were: $I_A = 120$ mA, $V_A = 55$ V $H = 360$ gauss. It is intended to use 2π emission c ions for a spiral orbit isotope separator.

T. G. PICKAVANC

537.542 : 535.8

4412. A stroboscopic mercury vapour light source E. K. FRANKL. Letter in *Nature* [*Lond.*] **169**, 32 (*Feb.* 23, 1952).

Describes a simple form of low pressure mercur arc for recurrent operation at rates up to 20/sec.

J. D. CRAGG

537.542

4413. Comparison of Geiger and proportiona counters for intensity measurements in X-ray diffraction U. W. ARNDT AND D. P. RILEY. Letter in *Proc. Phys Soc.* [*Lond.*] *A*, **65**, 74–5 (*Jan.*, 1952).

A calcite cleavage slip was used in a spectrometer with each detector in turn. The Geiger counter was filled with argon (externally quenched), the propor tional counter with argon and 8% ethanol. The latter, used with a kick-sorter, had the advantages of very low background and of discrimination against harmonic radiation. F. R. HOLT

537.542

4414. The ionization produced by high voltage radiation in an extrapolation chamber with walls of various atomic numbers and its relation to that to be expected theoretically. A. A. K. IBRAHIM AND C. W. WILSON. *Brit. J. Radiol.*, **25**,, 57–68 (*Feb.*, 1952).

Measurements with an extrapolation ionization chamber are described which aim to measure the ionization within chambers with high Z walls when the chamber dimensions are extrapolated to zero. The extrapolated values of ionization per unit volume are compared with those calculated from the Bragg–Gray theory. They agree well with the theoretical values for elements at least up to $Z = 13$ (Al) for radiations up to 0·5 Å. For elements of greater Z and for λ above about 0·10 Å, agreement is not found between the experimental results and the original theory. Better agreement can be obtained if the theory is modified so as to take into account the fact that in the ejection of the photoelectrons from the K shell of the wall material, an appreciable proportion of photon energy is used. The significance of these results is discussed from the point of view of measuring the energy absorbed in media. A.

537.542

4415. A method, using light flashes, for automatic determination of electrical impulses. E. H. MÜLLER. *S.B. Öst. Akad. Wiss. IIa*, **159**, 361–80 (*No.* 9–10, 1950) *In German.*

Using a small suspended mirror, the movement of which depends on the charge in an ionization chamber pulse, light from an intense source may be reflected on to a suitable light-sensitive emulsion in such a way that a spectrum of pulse sizes may be registered. Details of the method, and typical results, are given.

J. D. CRAGGS

537.542

4416. CO_2 ion-chamber techniques for radiocarbon measurement. G. L. Brownell and H. S. Lockhart. *Nucleonics*, **10**, 26–32 (*Feb.*, 1952).

The measurement of C^{14} activity, by means of an ionization chamber containing the active carbon as CO_2, is outlined. The theory of various circuits for measuring the chamber current is discussed and the construction of a suitable chamber and method of introducing the active CO_2 filling into it are described. L. R. SHEPHERD

537.542

4417. Conductivity crystal counters. A. G. Chynoweth. *Amer. J. Phys.*, **20**, 218–26 (*April*, 1952).

A brief review article on conductivity crystal counters in which their main properties and basic principles of operation are described. Their present position in the field of nuclear instrumentation is discussed, it being concluded that there are still many serious problems to be solved before the counters can be of practical use. Some of these problems and the present methods of tackling them are surveyed. A.

537.542 : 548.5

On the preparation of stilbene crystals. *See Abstr.* 4739

537.542

4418. Tests on scintillation G–M tubes. V. M. Daggs, W. H. Parr and A. T. Krebs. *Nucleonics*, **10**, 54–5 (*Jan.*, 1952).

Measurements of the response to polonium α-particles of certain commercial scintillation G.M. tubes (photon-sensitive G.M. tubes used as scintillation counters) are described. The response of the three types of tube examined was found to be less uniform than that of a thin window G.M. counter due to lack of uniformity of the phosphor. L. R. SHEPHERD

537.542

4419. Air equivalence of scintillation materials. W. B. Ittner, III and M. Ter-Pogossian. *Nucleonics*, **10**, 48–53 (*Feb.*, 1952).

The measurement of radiation dosage by means of scintillation counters entails the use of phosphors which are "air equivalent" over a wide energy range. In the case of γ-rays or X-rays above 250 keV the organic phosphors are essentially air equivalent. Experiments are described investigating the use of compound crystals of $CaWO_4$, $CaWO_4$ powder in transparent plastic resins and organic phosphors, which are air equivalent below 250 keV. L. R. SHEPHERD

537.542

4420. Some polystyrene solid solutions as scintillation counters. T. Carlson and W. S. Koski. Letter in *Phys. Rev.*, **85**, 697 (*Feb.* 15, 1952).

Comparisons are made of the counting efficiencies of 2% solutions of various hydrocarbons, such as stilbene, diphenylbutadiene, diphenylhexatriene, terphenyl, etc. (using Co^{60} γ-rays) in polystyrene. Diphenyl–acetylene and diphenyl–hexatriene give relatively poor response. G. F. L. GARLICK

537.542

4421. Note on the detection efficiency of scintillation counters for γ-rays. H. Piatier. *C.R. Acad. Sci. [Paris]* **234**, 939–41 (*Feb.* 25, 1952) *In French.*

A formula is derived for the detection efficiency of a scintillation counter when detecting γ-rays which produce only Compton encounters in the crystal. G. F. J. GARLICK

537.542

4422. Efficiency of a scintillation counter with anthracene phosphor for high-energy gamma-rays. O. Lönsjö. Letter in *Nature* [*Lond.*] **169**, 365–6 (*March* 1, 1952).

Using γ-rays of 6·2, 9·5 and 17·5 MeV the absolute counting efficiencies of a $2\times3\times3$ cm anthracene crystal is found to be 6, 5·5 and 4% respectively. Insertion of 1 mm Pb increases these efficiencies by 3·5, 6 and 11·5% respectively. G. F. J. GARLICK

537.542

4423. The response of anthracene scintillation crystals to high energy μ-mesons. T. Bowen and F. X. Roser. *Phys. Rev.*, **85**, 992–7 (*March* 15, 1952).

The response of an anthracene scintillation counter to high-energy charged particles which lose only a small fraction of their energy in traversing the crystal was determined, using μ-mesons in the cosmic radiation at sea level with energies from 29 MeV to greater than 1 BeV. The light output was found to have a sizeable fluctuation for mesons of the same initial energy, due to ionization loss straggling. The scintillation efficiency of the phosphor was found to decrease for increasing specific ionization, in agreement with the work of others on electrons and protons. The response of the crystal showed no rise within 2% for relativistic meson energies, which agrees with calculations of the density effect reduction in ionization loss. A.

537.542

4424. On the wavelength dependence of scintillation counters in the X-ray region. G. Breitling and R. Glocker. Note in *Naturwissenschaften*, **39**, 84 (*No.* 4, 1952) *In German.*

In the X-ray region from 0·4 to 2 Å the scintillation efficiency of anthracene falls slowly with wavelength. At shorter wavelengths it rises to the usual values for Compton encounters. Solutions of terphenyl in benzene, chlor-benzene and mixtures of the two show approximately constant efficiency between 0·25 and 0·75 Å with widely different behaviours at shorter wavelengths. G. F. J. GARLICK

537.542 : 535.371

4425. Molded multi-crystalline stilbene for scintillation counting. E. C. Farmer and I. A. Berstein. *Nucleonics*, **10**, 54–6 (*Feb.*, 1952).

Comparison of the light output from single crystals of stilbene and multicrystalline phosphors made by allowing molten stilbene in an Al mould to crystallize at room temperature, show that the latter are as good as the former in thicknesses up to 1·5 cm. The stilbene used was obtained by double recrystallization of the commercial product from ethyl acetate. Co^{60} and Se^{75} ($\sim 0{\cdot}2$ MeV) γ-rays were employed for the measurements. Variation of the light output with thickness of phosphor showed that the absorption coefficients of single and multi-crystal phosphors for their own emitted light were 0·20 cm^{-1} and 0·80 cm^{-1} respectively. L. R. SHEPHERD

537.542 : 539.166

4426. Scintillation counter as gamma ray spectrometer. V. O. ERIKSEN, G. JENSSEN AND A. SUNDE. *Physica*, **18**, 91–100 (*Feb.*, 1952).

The apparatus for γ-ray spectroscopy by means of a scintillation counter is described. The linearity between released photons and absorbed energy in NaI(Tl) for γ-rays in the region 0·05–0·5 MeV is verified. The γ-ray energy of Ru^{103} has been measured and found to be 0·52 MeV. Differential-discriminator runs and photographs of pulse distribution on an oscilloscope-screen are shown. A.

537.542 : 616-7

4427. The scintillation counter as an instrument for *in vivo* determination of thyroid weight. H. C. ALLEN AND W. E. GOODWIN. *Radiology*, **58**, 68–79 (*Jan.*, 1952).

Two forms of scintillation counter are described for measurements of uptake of I^{131} in the thyroid gland. One enables routine diagnostic tracer studies to be made with doses of 1 microcurie of I^{131}. The second, using a dose of 75 to 100 microcuries, makes possible a precise outlining of the iodine concentrating tissue in the neck. A method is presented for determination of thyroid weight from this result. This enables a "single dose" treatment of thyrotoxicosis to be undertaken. H. MILLER

537.542 : 621.318.572

4428. A fast amplitude discriminator and scale-of-ten counting unit for nuclear work. F. H. WELLS. *J. Sci. Instrum.*, **29**, 111–15 (*April*, 1952).

This instrument can accept randomly spaced pulses up to a rate of 10^6/sec and has a dead time of $0{\cdot}25 \pm 0{\cdot}05$ μsec after each recorded pulse. The scaling circuit, which is fully described, uses the technique of step-charging a capacitor from the discriminator output pulses. A new locking circuit is used for removing the effects of charge leakage from the condenser. A.

537.543 : 621.385.2 : 621.385.833

4429. Space-charge-wave propagation in a cylindrical electron beam of finite lateral extension. P. PARZEN. *J. Appl. Phys.*, **23**, 215–19 (*Feb.*, 1952).

A method is outlined for obtaining the effect of geometry on the propagation of space-charge waves in a cylindrical electron beam under arbitrary direct-current conditions. In particular, the case of the complete-space-charge diode is discussed in detail. The results of this theory are verified by the experiments of Cutler and Quate. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.172

4430. On the increase of the primary specific ionization at high energies. P. BUDINI AND G. POIANI. Letter in *Nuovo Cim.*, **9**, 199–201 (*Feb.*, 1952) *In Italian.*

Considerations developed in a previous paper [see Abstr. 2030 (1951)] for a vacuum are extended to a dispersive medium and values are calculated for the limiting percentage increase of the p.s.i. over its minimum value. For example for air in normal conditions the increase is 35%. L. PINCHERLE

537.56 : 539.1

4431. Ionization in oxygen by μ-mesons. S. K. GHOSH, G. M. D. B. JONES AND J. G. WILSON. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 68–9 (*Jan.*, 1952).

Measurements of ionization by μ-mesons in oxygen as a function of momentum shows an increase of about 30% between the minimum of ionization (~500 MeV/c) and 10 BeV/c. At high momenta, the limited data available suggest that further increase of ionization is suppressed. J. G. WILSON

537.564

4432. An instrument for the rapid determination of ionization efficiency curves using the mass spectrometer. G. R. HERCUS AND J. D. MORRISON. *Rev. Sci. Instrum.*, **23**, 118–20 (*March*, 1952).

An instrument is described which carries out automatically the measurement of ionization efficiency curves using the mass spectrometer. It operates by applying a scanning signal to the ion-accelerating voltage, whilst the ionizing-electron voltage is reduced by a motor-driven potentiometer, and a voltage-measuring unit prints voltage calibration marks on the mass spectrometer record. The time taken for a complete measurement is of the order of a few minutes. A.

537.564

4433. Mercury hydride ions in the mass spectrometer. F. J. NORTON. Letter in *Nature* [*Lond.*] **169**, 542 (*March* 29, 1952).

The intensity of $Hg^{202}H^+$ was proportional to (hydrogen pressure)$^{\frac{1}{2}}$ when mercury vapour and hydrogen were admitted into a 60° single-focusing mass spectrometer. Mass spectra are given.

T. G. PICKAVANCE

537.568

4434. Inelastic collisions between ions and atoms. J. B. HASTED. *Proc. Roy. Soc. A*, **212**, 235–48 (*April* 22, 1952).

Charge-exchange cross-sections for H^+, D^+, O_2^+, H_2^+, O^+, CO^+ and N_2^+ in A; D^+, O^+ and N^+ in Kr; D^+, C^+ and Br^+ in Xe; and O^+ in H_2O were measured between 25 and 4000 eV energy by a method described previously [Abstr. 3577 (1951)]. The normal atomic collision cross-sections rise to a maximum at a voltage which depends on the value of $\Delta E\sqrt{M}$ for the process, M being the atomic mass and ΔE the energy defect of the reaction. Collisions between negative ions and atoms were studied with the same apparatus, the cross-section of the detachment reaction $X^- + Y \rightarrow X + e + Y - \Delta E$ being obtained. For S^-, Br^-, I^-, C^-, P^-, Li^- in Ne, and H^- in He, Ne, A, Kr, Xe, this rises with increasing energy of the incident ion. For O^- in He, Ne, A, Kr, Xe, Cl^- in He, Ne, A, Kr, Xe and F^- in Ne, Kr, Xe the cross-section at low energies is unexpectedly large for the value of $\Delta E\sqrt{M}$. This may be interpreted as being due to the presence of excited states of these ions, of low electron affinities, in the beam. With O^-, a low energy electron bombardment source gave smaller

cross-sections, i.e. a smaller proportion of excited ions. A.

537.583 : 548.5

4435. Emission and crystal size of oxide-coated cathodes. J. SHIMAZU. *J. Phys. Soc. Japan*, **6**, 479–85 (*Nov.–Dec.*, 1951).

Several oxide cathodes, BaO, SrO, double and triple oxide which were converted from equal molar carbonate solid solutions, were studied. The thermionic emission of the oxides was measured by c.r.t. and the crystal size was determined by the method of small angle X-ray scattering. For this purpose the oxide materials were stripped from the Ni sleeves and coated by a protective film. The crystal size of oxides which were suitably converted from carbonates were found in the range from 200 to 300 Å except BaO. In the case of (BaSr)O, the emission and crystal size were measured at different stages of heat treatment. A.

537.583 : 621.385.032.216

4436. Correlation of d.c. and microsecond pulsed emission from oxide coated cathodes. F. A. HORAK. *J. Appl. Phys.*, **23**, 346–9 (*March*, 1952).

The oxide-coated cathodes were prepared on 4 different base metals. One of the base metals used was pure electrolytic Ni and the other 3 had impurities of 0·2% Si, 4% Si and 4·7% W added to the Ni. The flat base metal cathode was coated with equal molar barium-strontium carbonate. The tubes were placed on life test at a cathode temperature of 1125°K with no emission current drawn. D.C. and pulsed emission measurements were taken periodically. Three methods were used to measure the zero field emission current, (1) d.c. retarding potential, (2) d.c. Schottky, and (3) pulsed Schottky. These gave essentially the same Richardson plot indicating a positive correlation of d.c. and pulsed emission. From these Richardson plots obtained using methods (1) and (3), the work function, the emission constant and J_0, the characteristic emission current density at 650°K, were determined. The results show that the different cathode base metals control the variation in emission with life. The emission from the W–Ni base metal is stable with life and is of much higher value than the other base metals. A.

COSMIC RAYS 537.591

537.591

4437. The origin of cosmic rays in solar or stellar disturbances. L. RIDDIFORD AND S. T. BUTLER. *Phil. Mag.*, **43**, 447–56 (*April*, 1952).

Charged particles may attain cosmic-ray energy by betatron acceleration in trochoid-like orbits in the varying magnetic fields which occur in star spots. For sunspots, cyclic acceleration produces maximum energies of about 10^{13} eV for protons and 10^{15} eV for heavier particles. If the source of ions is constant, the differential number-energy spectrum of the relativistic particles has the form of an inverse power law. The power in this law is the same for protons and heavier particles, and lies between 1·7 and 3·0 independently of assumptions about the constants of the spot. A.

537.591.1

4438. A study of the properties of the penetrating particles of cosmic radiation in the stratosphere. K. I. ALEKSEEVA, S. N. VERNOV AND R. M. OSOKINA. *Dokl. Akad. Nauk SSSR*, **80**, 725–8 (*No.* 5, 1951) *In Russian.*

An improved counter system is described for the simultaneous determination of the numbers of shower-producing particles with ranges of 4 to 8 and > 8 cm Pb. An analysis of flights up to 24·8 km shows that between 15 and 20 km cosmic radiation contains (*a*) 1·0–1·5 electrons min^{-1}, $sterad^{-1}$, cm^{-2} with energies 2×10^8–7×10^8 eV (range 4–8 cm Pb), (*b*) 1·0 proton and meson min^{-1}, $sterad^{-1}$, cm^{-2} with range 4–8 cm Pb. W. J. SWIATECKI

537.591.1

4439. On the masses of charged particles of the cosmic radiation in nuclear emulsions. S. YAMAGUCHI AND M. TAKAHATA. Note in *J. Phys. Soc. Japan*, **6**, 397–8 (*Sept.–Oct.*, 1951).

Range *v.* grain count determinations of mass for particles found in 50 μ emulsions exposed at 2840 m altitude are reported. J. G. WILSON

537.591.1

4440. An application of proportional counters to mass determination. M. INOKI. Note in *J. Phys. Soc. Japan*, **6**, 398–400 (*Sept.–Oct.*, 1951).

A cloud chamber was controlled by a threefold counter telescope of which two counters, within the chamber, were operated in the proportional region and yielded deflections recorded simultaneously with the cloud chamber picture. The chamber also contained a series of metal plates and mass determinations by ionization-range were made at sea level. About 10^{-4} of cosmic-ray particles at sea level are slow μ-mesons arrested by 1mm Al. J. G. WILSON

537.591.1

4441. Masses of particles in cosmic rays. S. AZIMOV, N. BIRGER, N. DOBROTIN, G. ZHDANOV, YU. KOKURIN AND S. SLAVATINSKIĬ. Transl. in *Guide Russ. Sci. Period. Lit. Brookhaven*, **4** (*No.* 11) 339–42 (*Nov.*, 1951).

Full translation of article abstracted in Abstr. 9568 (1951).

537.591.1

4442. On the energy spectrum of the nucleonic component at various altitudes. G. CORTINI, A. MANFREDINI AND G. SEGRÈ. Letter in *Nuovo Cim.*, **9**, 191–3 (*Feb.*, 1952) *In Italian.*

The number of stars produced in G5 emulsions was determined at 60 g/cm² from the top of the atmosphere. A comparison with previous measurements at lower altitudes shows that (1) the differential multiplicity spectrum does not depend on the altitude; (2) the mean free path in air of the nucleonic component is 108 ± 5 g/cm²; (3) the ratio between the number of neutrons and that of protons increases very slowly. It is pointed out that results based on the study of low multiplicity stars are doubtful because of the geomagnetic cut-off. L. PINCHERLE

537.591.1

4443. The differential range spectrum of cosmic-ray mesons at sea level. C. M. York, Jr. *Phys. Rev.*, **85**, 998–1003 (*March* 15, 1952).

The low-energy region of the differential range spectrum of cosmic-ray mesons at sea level has been investigated by means of a counter-controlled cloud chamber. The results obtained in the region from 18 g/cm² to 76 g/cm² of air equivalent absorber have proved to be about 20% higher than predictions based upon similar measurements at greater absorber thicknesses. A possible explanation of this discrepancy lies in the consideration of the effect of multiple scattering of mesons in previous experiments. The present experiment employs a geometrical arrangement of the apparatus which minimizes the corrections to be applied to the data to allow for loss of mesons from the apparatus due to scattering. The earlier work in the field has not been corrected for scattering effects and can, as a result, be expected to give too low a value of the spectrum. The average differential intensity of mesons measured in the range interval mentioned above is $6{\cdot}86\times10^{-6}$ (particles/sec/sterad/g). The differential range spectrum of protons was also measured and is in good agreement with other work which measured the spectral values at somewhat higher energies than those encountered here. The proton intensity is $2{\cdot}12\times10^{-6}$ (particles/sec/sterad/g) in the region 16·5 to 42·3 g/cm² of air equivalent and $0{\cdot}67\times10^{-6}$ (particles/sec/sterad/g) in the region 42·5 to 63·3 g/cm² of air equivalent. A.

537.591.15

4444. On the photodisintegration of heavy cosmic-ray particles coming under the influence of solar radiation. G. T. Zatsepin. *Dokl. Akad. Nauk SSSR*, **80**, 577–8 (*No.* 4, 1951) *In Russian.*

Due to the Doppler effect the energies of solar photons in the system of reference of fast cosmic-ray particles may exceed 10^7 eV, when nuclear photo-effects begin. The resulting disintegrations occurring some km above the earth would produce correlated systems of showers which could explain the observed correlations in shower recording counters separated by ~1 km. W. J. Swiatecki

537.591.15

4445. On a nuclear cascade process in air-extensive cosmic ray showers. I. L. Rozental. *Dokl. Akad. Nauk SSSR*, **80**, 731–4 (*No.* 5, 1951) *In Russian.*

In connection with the importance of nuclear cascades in the development of such showers the dependence of the intensities of the various components (e, μ, H, π) on the depth below the top of the atmosphere is calculated (neglecting ionization loss and making other simplifying assumptions) and the result is illustrated graphically. W. J. Swiatecki

537.591.15

4446. A cloud chamber study of the electronic component of extensive air showers. C. B. A. McCusker and T. E. Nevin. *Proc. Roy. Irish Acad. A*, **54**, 201–4 (*No.* 13, 1951).

A cloud chamber containing six 0·33 cm Pb plates is used to determine, from shower development in the plates, the energy of extensive shower electrons as a function of shower density. Over the shower densities studied, there is no detectable difference in average electron energy. J. G. Wilson

537.591.15

4447. A hodoscope study on the penetrating shower. Y. Watase, M. Oda, T. Kubozoe and S. Higashi. *J. Phys. Soc. Japan*, **6**, 402–3 (*Sept.–Oct.*, 1951).

The multiplicity spectrum of particles in local penetrating showers from Pb and C, and their penetration in Pb were determined in a conventional type penetrating shower array in which additional hodoscopic counter trays were placed below a variable lead screen underneath the apparatus. J. G. Wilson

537.591.15

4448. A study on the extensive air shower. Y. Watase, M. Oda, S. Higashi and T. Kubozoe. Note in *J. Phys. Soc. Japan*, **6**, 403–4 (*Sept.–Oct.*, 1951).

A modification of the apparatus (preceding abstract), in which a hodoscoped counter tray gave an estimate of the density of air showers, was used to investigate the penetration and multiplicity of penetrating phenomena associated with these showers. It is concluded that the percentage of penetrating particles increases from the usually adopted 2% in very dense showers. J. G. Wilson

537.591.15

4449. The lateral spread of cosmic-ray showers in air and lead. H. S. Green and H. Messel. Letter in *Phys. Rev.*, **85**, 679 (*Feb.* 15, 1952).

The lateral spread of the nucleonic component of cosmic-rays ("the nucleon cascade") is determined for an isothermal atmosphere, for cross-section 75 g cm^{-2} of nucleon air-nucleus collisions and for a 1·1 power law of primary energy over the relevant range. The resulting spread is rather sensitive to the form of the primary spectrum, and the analysis generally leads to much larger spreads than those predicted for a pure electron–photon cascade originating in the high atmosphere. J. G. Wilson

537.591.15

4450. Absence of secondary maxima in the transition curve for electronic showers. R. Maze. Letter in *Phys. Rev.*, **85**, 697 (*Feb.* 15, 1952).

Previous measurements [Abstr. 2795, 8817 (1951)] in which a "second maximum" of the Rossi curve at about 7 cm Pb absorber was reported have been repeated with further counters close to the supposed shower-producing layer in order to establish that this is indeed the shower source. The resultant curve (points to 1%) shows no trace of the 7 cm maximum. J. G. Wilson

537.591.5

4451. Zenith-angle distribution of cosmic rays. A. G. Voisin. *Canad. J. Phys.*, **29**, 505–17 (*Nov.*, 1951) *In French.*

Significant variations from the $\cos^2\theta$ zenith-angle distribution of the integral sea-level cosmic ray beam have been established for low momentum groups, (i) 300–410 MeV/c; (ii) 410–510 MeV/c. J. G. Wilson

537.591.5

4452. Diurnal variations in high energy cosmic-ray intensities. P. H. BARRETT AND Y. EISENBERG. Letter in *Phys. Rev.*, **85**, 674 (*Feb.* 15, 1952).

Five large counter telescopes of broad collection and each of counting rate $\sim 10\ h^{-1}$ at 1600 m.w.e. depth yielded about 10^5 counts at this depth. There is no trace of a solar-time variation, but the possibility of a sidereal variation, which, however, does not confirm the reported maximum [Abstr. 8446 (1951)] at 1520 local sidereal time. J. G. WILSON

537.591.5

4453. The high latitude east-west asymmetry of cosmic rays. D. W. P. BURBURY AND K. B. FENTON. *Aust. J. Sci. Res. A*, **5**, 47–58 (*March*, 1952).

Measurements of the east-west asymmetry of cosmic rays at sea-level have been made at Hobart and Macquarie Island in geomagnetic latitudes 51·7 and 60·7°S respectively. The values obtained have been found to agree satisfactorily with values calculated using a revised form of Johnson's theory [*Phys. Rev.*, **59**, 11 (1941)]. A.

537.591.8

4454. On the calculation of average numbers for the electron-photon cascade. L. JÁNOSSY AND H. MESSEL. *Proc. Roy. Irish Acad. A*, **54**, 217–43 (*No.* 15, 1951).

Detailed tables for the average numbers of electrons or photons above a given energy at various depths and graphs for practical use were calculated in "approximation A" of Jánossy's "Cosmic Rays," Oxford, 1950. Also tables of approximate corrections for ionization loss based on Bhabha and Chakrabarty [Abstr. 1976 (1943)]. W. J. SWIATECKI

537.591.8

4455. Observations on the interactions of μ-mesons underground. E. P. GEORGE AND P. T. TRENT. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 1134–5 (*Dec.*, 1951).

Experiments at 60 m.w.e. depth are interpreted to indicate anomalous scattering of μ-mesons with cross-section of the order $2\cdot10^{-28}$ cm²/nucleon, and the production by μ-mesons of penetrating secondaries with a lower limit of cross-section $4\cdot10^{-29}$ cm²/nucleon. J. G. WILSON

537.591.8

4456. Production of π mesons by cosmic rays in Pb and Al. N. DALLAPORTA, M. MERLIN, O. PIERUCCI AND A. ROSTAGNI. Letter in *Nuovo Cim.*, **9**, 202–4 (*Feb.*, 1952) *In Italian.*

Nuclear plates were surrounded by metal blocks. The no. of stars was taken as a measure of the no. of π^- and the no. of $\pi\to\mu$ events as a measure of the no. of π^+. The cross-sections per nucleus in Al and Pb were found to be about the same. The average energy with which mesons were generated was found to be $\bar{E}_{Al} \simeq 85$ MeV; $\bar{E}_{Pb} \simeq 105$ MeV. L. PINCHERLE

537.591.8

4457. Extremely high energy nuclear interactions. M. F. KAPLON AND D. M. RITSON. Letter in *Phys. Rev.*, **85**, 932 (*March* 1, 1952).

Using an "emulsion cloud chamber" to select high energy events (see also abstract following) a study was made of the angular distribution, multiplicity of penetrating particles and ratio of neutral mesons to charged particles produced by collisions of cosmic-ray nucleons and α-particles with nuclei of Cu (15 showers in all). General agreement with the Fermi theory was found. W. J. SWIATECKI

537.591.8

4458. Primary flux of high energy protons and α-particles. M. F. KAPLON, D. M. RITSON AND E. P. WOODRUFF. Letter in *Phys. Rev.*, **85**, 933 (*March* 1, 1952).

Using the emulsion cloud chamber technique (preceding abstract) flux values in the region 10^{12}–10^{13} eV were obtained. Assuming a power law for the primary spectrum and using known low energy values, an exponent of $1\cdot45 \pm 0\cdot15$ was found. Two out of 16 observed showers with energies $\sim 4\cdot5\times10^{12}$ eV were produced by α's. W. J. SWIATECKI

537.591.8

4459. Shape of cosmic-ray star-size distributions in nuclear emulsions. M. BIRNBAUM, M. M. SHAPIRO, B. STILLER AND F. W. O'DELL. *Phys. Rev.*, **86**, 86–9 (*April* 1, 1952).

The occurrence of a break in integral star-size distributions at a prong number of approximately 7, previously observed with nuclear emulsions in the lower atmosphere, has also been found at several stratosphere altitudes under a variety of conditions. This shows that the effect is due mainly to the composition of the nuclear emulsion. Although the shape of the distribution curves is thus strongly influenced by the properties of the detector, the altitude dependence of the nucleonic energy spectrum is clearly reflected in the progressive change in the slopes of these curves. A.

MAGNETISM 538

538.082.74 : 550.384.08

4460. Analysis of the variation of magnetic flux by means of parallel-connected fluxmeters. A. G. KALASHNIKOV. *Dokl. Akad. Nauk SSSR*, **80**, 743–6 (*No.* 5, 1951) *In Russian.*

The fact that the reading of a fluxmeter remains practically unaffected when a number of other fluxmeters of different frequency characteristics are connected in parallel with it, is utilized in the harmonic analysis of terrestrial magnetism. F. QUELON

538.114

4461. On the quantum theory of antiferromagnetism. H. A. KRAMERS. *Physica*, **18**, 101–3 (*Feb.*, 1952).

Objections, raised against the Weiss–Néel treatment of antiferromagnetism, are discussed. The maximum magnetization of the sub-lattice must be expected to be only a fraction of that following from a linear alignment of their spins. It is pointed out that a division of a linear antiferromagnetic chain into two sub-lattices with different magnetization, as supposed in the above-mentioned method, will probably occur if a certain minimum amount of anisotropy in the exchange forces is exceeded. A.

538.114

4462. The lowest energy state of a linear antiferromagnetic chain. P. W. KASTELEIJN. *Physica*, **18**, 104–13 (*Feb.*, 1952).

In the ground state of a one-dimensional crystal with isotropic antiferromagnetic exchange a division of the chain into two sub-lattices as suggested by the theory of Weiss–Néel does not obtain. It is proved, however, that after introduction of a certain amount of anisotropy a subdivision will appear. Generalizing a method developed by Slater and Hulthén this critical value of the relative anisotropy is approximated by means of the Ritz variation method and the relation between the magnetization of the two sub-lattices and the anisotropy above this value is investigated. A.

538.114

4463. Line widths in ferromagnetic resonance. K. W. H. STEVENS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 149–50 (*Feb.*, 1952).

The occurrence of g values ~ 2 (e.g. 2·23 at 24°C in Ni) and of non-integral magneton numbers (e.g. 0·606 in Ni) in ferromagnetic metals is ascribed to the occurrence of ions with different configurations and a rapid fluctuation of configurations from site to site. The line width should depend on the life time of a given magnetic site. An experiment on Gd metal is suggested, and here very narrow absorption lines are predicted since the magneton number is integral and there are, therefore, apparently no fluctuations. E. P. WOHLFARTH

538.12 : 530.162

4464. A note on the statistics of the Weiss field. G. M. BELL. *Phil. Mag.*, **43**, 127–9 (*Jan.*, 1952).

Considering an assembly of N magnetic dipoles with two orientations relative to an applied field (N_1 oriented along the field, N_2 against it) it is shown that a partition function from which correct expressions for the magnetization and free energy can be derived, simply by differentiation, provided that the summation is made for each value of $m = (N_1 - N_2)/N$, only over those sets of occupation numbers which are consistent with that value of m. T. C. TOYE

538.221

4465. Domain structure of Perminvar having a rectangular hysteresis loop. H. J. WILLIAMS AND M. GOERTZ. *J. Appl. Phys.*, **23**, 316–23 (*March*, 1952).

An investigation was made of the magnetic domain structure of Perminvar (43% Ni, 34% Fe, 23% Co) ring specimens having rectangular hysteresis loops after heat-treatment in a magnetic field. Domain patterns obtained with colloidal magnetite showed curved domain boundaries extending completely around the rings, forming circles concentric with them. Changes in magnetization occur when an applied field causes the circular boundaries either to expand or contract so that there is a change in the relative values of clockwise and counter-clockwise flux. A nucleus of reversed magnetization was formed by making a small notch in a specimen, and this decreased the coercive force and hysteresis loss by a factor of two. It was found that in a 180° domain boundary it was possible to make the change in spin orientations, which occurs in going from one side of the boundary to the other, have either a right- or left-hand screw relation, by the application of a field of appropriate sign perpendicular to the surface. The effect of superposing an applied alternating field was also investigated, and an effective permeability of 4 000 000 was obtained. A.

538.222

4466. The origin of high permeability in permalloy. S. CHIKAZUMI. Letter in *Phys. Rev.*, **85**, 918 (*March* 1, 1952).

An alloy of composition Ni_3Fe when annealed or slowly cooled in a magnetic field exhibits high permeability μ in the direction of the applied field, which is attributed to a directional ordering of the structure. But the same alloy quenched also shows a high μ, inexplicable on this basis. Reasons are given for expecting that the progressively less regular and more finely divided domain structure which was observed, as the amount of disorder was increased, may itself give rise to a high μ. A. D. LE CLAIRE

538.222

4467. Paramagnetic resonance absorption in organic free radicals. Fine structure. C. A. HUTCHISON, JR., R. C. PASTOR AND A. G. KOWALSKY. Letter in *J. Chem. Phys.*, **20**, 534–5 (*March*, 1952).

This was measured at 23·500 Mc/s, at room temperature, in $(C_6H_5)_2NNC_6H_2(NO_2)_3$ solutions in C_6H_6. The resonance width varied with concentration; fine structure was less observable in more concentrated solutions and may be explained as nuclear hyperfine structure. J. JACOBS

538.222

4468. Line width of paramagnetic resonance and exchange interaction in salts containing Mn^{++} and Fe^{+++}. H. KUMAGAI, K. ÔNO AND I. HAYASHI. Letter in *Phys. Rev.*, **85**, 925 (*March* 1, 1952).

Narrow paramagnetic resonance lines and large values of θ in the Curie–Weiss law $\chi_s = c/(T + \theta)$ occur together. This is semi-quantitatively justified as they both depend, $\Delta H_{\frac{1}{2}}$ inversely and θ directly, on J, the spin exchange integral. D. H. WHIFFEN

538.222

4469. On the influence of nuclear spin and of super-exchange on the spin specific heat of $Cu(NH_4)_2(SO_4)_2 . 6H_2O$. F. W. DE VRIJER. *Physica*, **18**, 194–8 (*March*, 1952).

It is well known that the specific heat of the spin system of most cupric salts is much higher than can be explained by magnetic interaction alone. This is generally thought to be due to super-exchange interaction. Since the Cu nuclei carry a magnetic moment it has to be expected that interaction with the electronic spin of the ion will cause a small splitting, which will also contribute to the specific heat of the spin system. The magnitude of this effect has been determined in the case of $Cu(NH_4)_2(SO_4)_2 . 6H_2O$ by comparing paramagnetic relaxation measurements on this salt with results obtained with a magnetically diluted isomorphous double-salt (5% Cu^{++}, 95% Mg^{++}). A.

538.222 : 536.48

4470. Magnetic properties of metals at low temperatures. G. E. ZILBERMAN. *Zh. Eksper. Teor. Fiz.*, **21**, 1209–17 (*No.* 11, 1951) *In Russian.*

The theory of the de Haas-van Alphen effect is discussed, and the influence of spin paramagnetism is considered in a way which permits of generalization to the anisotropic case [see Abstr. 2825 (1952)]. The experimental data for beryllium and zinc are compared with experiment and estimates are made of the electronic parameters for these metals. Some discussion is given of the very small numbers of free electrons ($\sim 10^{-5}$ to 10^{-6} per atom) which emerge from these and other comparisons and it is concluded that the de Haas-van Alphen effect is closely connected with interactions between electrons (ignored in the theory) rather than interactions between the electrons and the periodic field of the lattice.

D. SHOENBERG

538.224

4471. Magnetic anisotropy of indium single crystals. I. VERHAEGHE, G. LE COMPTE AND G. VANDERMEERSSCHE. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **13**, 9 *pp.* (*No.* 8, 1951) *In Dutch.*

The diamagnetic susceptibilities of In single crystals at R.T. were measured by the Gouy method. The ratio $\chi_{\parallel}/\chi_{\perp}$ was found to be 0·44; the mass susceptibility of a polycrystalline sample was $-0{\cdot}076\times10^{-6}$.

E. P. WOHLFARTH

538.23

4472. The determination of the magnetization curve and hysteresis loop at temperatures up to the Curie temperatures in various alloys of iron and molybdenum. W. SUCKSMITH. *Rep. Brit. Elect. Res. Ass., Ref. N/T*50, 15 *pp.* (1950).

The main constructional features of a high temperature permeameter working up to 850°c are described and the results of some measurements made with it of the hysteresis loops of some alloys of the Fe–Mo system are discussed. A.

538.24 : 548.74

4473. Physical structure and magnetic anisotropy of Alnico 5. I. R. D. HEIDENREICH AND E. A. NESBITT. *J. Appl. Phys.*, **23**, 352–65 (*March*, 1952).

It is concluded from electron metallographic results that the high coercive force and anistropy of Alnico 5 are caused by a very finely divided precipitate produced by the permanent magnet heat-treatment. This precipitate is a transition structure rich in cobalt and is face-centred cubic with $a_0 = 10$ Å and appears as rods growing along the [100] directions of the matrix crystal when no magnetic field is applied during heat treatment. The size of the precipitate rods at optimum properties is approximately 75–100 Å by 400 Å long. The spacing between rows of rods is about 200 Å. The rods are not distinctly resolved in the electron images unless they are grown by aging at 800°c. Their orientation and structure is clearly evident in the electron diffraction patterns at all stages of growth. The precipitate responds to a magnetic field applied during heat-treatment both by suppression of nuclei making an angle greater than about 70° with the field and by the forcing of the rods off the [100] direction into that of the field. The precipitate rods tend to scatter in direction about the field vector when the field is off the [100] but are aligned accurately when the field is along [100]. A.

538.24 : 548.74

4474. Physical structure and magnetic anisotropy of Alnico 5. II. E. A. NESBITT AND R. D. HEIDENREICH. *J. Appl. Phys.*, **23**, 366–71 (*March*, 1952).

As a result of measurements of magnetic anisotropy and coercive force on single crystals of Alnico 5 and the electron metallography of Pt I, the following conclusions were obtained. When the crystals are heat treated in a field in the principal crystallographic directions, the easy direction of magnetization is the field direction, and magnetically the crystals have twofold symmetry. However, there is a strong tendency because of crystal forces for the precipitate to grow in ⟨100⟩ directions; and, therefore, the crystal has the highest anisotropy when the heat-treating field and a ⟨100⟩ direction are parallel. The large increase in residual induction of Alnico 5 which results from the magnetic field heat treatment is caused by the easy directions of the crystal changing from the ⟨111⟩ directions to a single easy direction approximately parallel to the field. Domain rotations rather than boundary movements account for the coercive force of the alloy, since the dimensions of the individual particles are approximately 200 Å. The present physical picture of the alloy is one of single domains of precipitate material in parallel with single domains of matrix material, the observed coercive force being the resultant of this parallel combination. A.

538.247 : 538.653.1

Mechanical Barkhausen effect. *See Abstr.* 4500

538.248

4475. On the magnetic after-effect due to the irreversible displacement of the domain boundary. III. S. MAEDA. *J. Phys. Soc. Japan*, **6**, 444–9 (*Nov.–Dec.*, 1951).

For Pt. II, see Abstr. 5591 (1951). The magnetic after-effect of C-steel was measured in the cases of constant initial field (saturation field) and various values of final field which correspond to various points on the descending branch of the magnetic hysteresis curve. The amount of after-effect observed was larger than that of Cr-Permalloy reported in previous papers and various forms of damping characteristic curves were obtained. The form of $Bn(t)$, the total change of magnetization during the period from t sec after the instant of the field change, shows a slower change than $B_n(t) \propto 1/t$, for final fields stronger than $H_f(max)$, for which the after-effect takes a maximum value, and a more rapid change than that of $1/t$ law for the values of H_f smaller than $H_f(max)$. Furthermore the form of $B_n(t)$ was changed sensibly by the change of temperatures and tensions applied. However, it was found that these features of the characteristic curves of $B_n(t)$ were explained well quantitatively by a model based on the irreversible displacement of domain boundary. According to the theory $B_n(t)$ was given by $B_n(t) = kD/a\int_t^{\infty} \beta(H_{om})1/t^2\,dt$ where k, D and a are constants and $\beta(H_{om})$ is an amount which depends on the form of the magnetic hysteresis loop of the specimen. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

4476. The foundations of a new electromagnetism. B. JOUVET. *C.R. Acad. Sci.* [*Paris*] **234**, 819–22 (*Feb.* 18, 1952) *In French.*

The general nature of the laws of composition of fields *in vacuo* is discussed under the assumption that they form an Abelian group subject to Born's condition, $E^2 - H^2 \leqslant$ a universal constant. R. A. NEWING

538.3 : 53.081.4 : 621.3.081.1

4477. Definition of magnitudes and interrelation between units in electrodynamics. U. STILLE. *Arch. Elektrotech.*, **40**, 249–56 (*No.* 4, 1952) *In German.*

Opposes Fischer's views [*Arch. Elektrotech.*, **39**, 711–17 (*No.* 10, 1950)] on the conditions for a reasonable definition of a physical magnitude. He claims an independent justification for different systems of units such as those based on 4 fundamental magnitudes (like the MKSA-system) and others based on 3 magnitudes (as the c.g.s.-system). The choice depends on the physical relations and methods of their measurement. The present preferred definition of the system of units by 4 basic magnitudes is compatible only with the assumption that in a vacuum, electrical field strength and electrostatic displacement or flux density and magnetic field strength are physically distinct conceptions. This in his view is contradicted by modern physics. The point is elucidated by a mechanical analogue. E. FRIEDLANDER (R)

538.3 : 53.081.4 : 621.3.081.3

4478. Definition of magnitudes and interrelation between units in electrodynamics. J. WALLOT. *Arch. Elektrotech.*, **40**, 256–7 (*No.* 4, 1952) *In German.*

Refutes the views expressed by Stille (preceding abstract) because it is wrong to assume that in the past a system of only 3 basic units was actually used even if ε_0 and μ_0 were chosen $= 1$. E. FRIEDLANDER (R)

538.3 : 53.081.4 : 621.3.081.1

4479. Magnitudes and units in the science of electricity. J. FISCHER. *Arch. Elektrotech.*, **40**, 257–62 (*No.* 4, 1952) *In German.*

Replies to the objections by Stille [Abstr. 4477 (1952)] with reference to this author's assumption that a system based on 3 chosen units was proposed and used in the past. He shows by means of quotations from the earlier literature that it is wrong to assume the choice of $\varepsilon_0 = 1$ and $\mu_0 = 1$ by earlier physicists to indicate that electric field strength and dielectric displacement or magnetic field strength and flux density were thought to be physical identities. This erroneous opinion has in his view been largely due to the c.g.s.-system having been invented at a time when the conceptions of ε_0 and μ_0 were still unknown. He particularly objects to Stille's assumption that one could base a reasonable choice of units and dimensions on quantities which are defined only by methods of measurement. E. FRIEDLANDER (R)

538.311

4480. Experimental determination of the magnetomotive force exerted by a displacement current. G. VALLAURI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **12**, 17–19 (*Jan.*, 1952) *In Italian.*

A magnetic circuit was placed between the plates of a condenser to which was applied an alternating e.m.f. A coil was wound round the magnetic circuit and the e.m.f. induced in this coil detected the m.m.f. produced by the displacement current. The effect is difficult to measure, but, within experimental error, results were in agreement with Maxwell's first current equation. L. PINCHERLE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.5

4481. An asymptotic solution of Maxwell's equations. M. KLINE. *Commun. Pure Appl. Math.*, 4, 225–62 (*Aug.*, 1951).

A method is developed for finding approximately the nontransient part of the electromagnetic field (E, H) due to a harmonically varying charge distribution $\rho \exp(-i\omega t)$, which comes into existence at time $t = 0$ in an isotropic medium where ε, μ, and σ are sectionally continuous functions of (x, y, z), with finite discontinuities at certain boundaries. By means of Duhamel's principle the field (E, H) is expressed in terms of the field (E_0, H_0) created by the same charge-distribution coming into existence at $t = 0$ and thereafter remaining constant. E and H are found in the forms $u \exp(-i\omega t)$ and $v \exp(-i\omega t)$, where u and v are asymptotic series in $1/\omega$, the nth coefficient in the series for u being the sum of the discontinuities with respect to t of the $(n-1)$th time-derivative of E_0, and similarly for v. These discontinuities are determined without explicitly evaluating E_0 and H_0 by recasting Maxwell's equations into the form of integral equations, which admit of discontinuous solutions. The fact that the discontinuities occur on the wave-fronts passing any point leads to a system of ordinary differential equations for their determination. The first approximation to the solution gives the ordinary geometrical optics results, while the second approximation gives a significant improvement on this. Application of the method to the dipole field in a non-homogeneous medium is considered. A. T. PRICE

538.56

4482. The jumps of discontinuous solutions of the wave equation. H. BREMMER. *Commun. Pure Appl. Math.*, **4**, 419–26 (*Nov.*, 1951).

By substituting a suitably constructed discontinuous function $u(x, y, z, t)$ in the scalar wave equation $\Delta u = n^2 \ddot{u}/c^2$, and equating to zero the coefficients of the Dirac functions $\delta(\phi)$ and $\delta'(\phi)$, where $\phi(x, y, z, t) = t - (1/c)S(x, y, z)$ is the wave front, the eiconal equation $|\text{grad } S| = \pm n$ is obtained together with the equation $\Delta S u^* + 2n(du^*/ds) = 0$, satisfied by the discontinuity u^* on the wave front, d/ds denoting differentiation along a ray-trajectory. The same equation is satisfied by the amplitude of steady-state harmonic solutions for vanishingly small wavelengths. The extension to the vector equations of the electromagnetic field is discussed, and a verification is obtained of Luneberg's statement that the magnitudes of the discontinuities in the pulse solution are identical

ith the amplitudes of the geometric-optical steady-tate solution. A. T. PRICE

538.56

4483. The transport of discontinuities in an electromagnetic field. E. T. COPSON. *Commun. Pure Appl. Math.*, **4**, 427–33 (*Nov.*, 1951).

The differential equations, previously derived by .uneberg [mimeographed lectures, *The Mathematical Theory of Optics*, Brown University (1944)], for the propagation of discontinuities of E and H in an sotropic non-homogeneous dielectric, are derived in a impler manner, by replacing the vector wave equations by equivalent integral equations, and then lefining a generalized solution of these equations. A. T. PRICE

538.565

4484. On a method of calculating e.m. field inside closed spherical shell with variable dielectric constant. R. G. MIRIMANOV. *Dokl. Akad. Nauk SSSR*, **80**, 561–4 (*No.* 3, 1951) *In Russian.*

It is assumed that the e.m. field and the currents in he shell are induced, in the first place, by fully known ources, implying that these sources are not affected y secondary fields. The analysis is based on e.m. quations in vectorial form. The secondary potentials re developed in series of cylindrical and spherical armonics, assuming that the applicability of this orm of solution is assured by the fact that the olutions of the equations of e.m. field must also atisfy the wave equation. The application of these eries to the boundary of the shell yields the expressions for the complex coefficients of the series. The final formulae reduce the problem to the solution of linear differential equations with constant coefficients with only one independent variable (time). N. S. JAPOLSKY

538.566

4485. Limiting absorption principle for a wave conductor. A. G. SVESHNIKOV. *Dokl. Akad. Nauk SSSR*, **80**, 345–7 (*No.* 3, 1951) *In Russian.*

In the case of the electromagnetic wave equation $\Delta u + k^2u = -f(Z, M)$ $[M = (x\,y)]$ inside an infinite cylindrical conductor Σ, on the surface of which $u|_\Sigma = 0$ or $du/dn|_\Sigma \doteq 0$, a unique solution requires an additional condition such as the absence of waves originating at infinity. This is shown to be equivalent to a "partial radiation" condition analogous to that of Sommerfeld. Limiting absorption principle, a special form of this condition, requires finding the solution of the wave equation as the limit of the solution of wave equation with a complex coefficient $k_1^2 = k^2 + i\varepsilon$ $(\varepsilon > 0)$ when $\varepsilon \to 0$, and is independent of the shape of the region in which the solution is sought. A. GELBTUCH

538.566

4486. Reduction of three dimensional electromagnetic problems. J. W. MILES. Letter in *J. Appl. Phys.*, **23**, 372 (*March*, 1952).

Diffraction problems are considered in which the generators of the diffracting surface and its boundaries are everywhere parallel to the z-axis, but the incident wave is not parallel to this axis. Specific formulae are given for reducing such problems to a pair of 2-dimensional scalar problems. A. T. PRICE

538.566

4487. Flow over thick plate with circular hole. W. R. SMYTHE. *J. Appl. Phys.*, **23**, 447–52 (*April*, 1952).

Formulae are derived for the scalar potential of a uniform magnetic field parallel to the plane face of an infinite nonpermeable medium in which a circular hole of radius, a, is drilled normally. Outside the hole the formulae is an oblate spheroidal harmonic series for which 11 coefficients are given, and inside it is a Bessel function series for which 20 coefficients are given. The case of a flat-bottomed hole whose depth is greater than its diameter is included. All series converge slowly in the plane of the opening but rapidly elsewhere. When a plane electromagnetic wave falls on such a hole, the fraction of the energy scattered is approximately $11 \cdot 7(2a/\lambda)^4 \cos\theta$ if the wavelength λ is much greater than $2a$ and θ is the angle of incidence. Such a hole in the thick plane wall of a resonant cavity, at a point where H is uniform and E is zero, decreases the resonance frequency ω by $0 \cdot 2366\,\mu a^3 H^2 W_m^{-1}\omega$ where W_m is the magnetic energy in the cavity when H is measured. A lug of radius a affixed to the plane face of a cylindrical rod of the same material, length l and cross-section A changes the resistance in the ratio $[1 + 0 \cdot 3154a^3/(Al)]^{-1}$. A.

538.566 : 534.26

Multiple scattering of radiation by an arbitrary planar configuration of parallel cylinders and by two parallel cylinders. *See Abstr.* 4192

538.566 : 621.396.671

4488. Radiation or diffraction patterns close to receiving antennas. L. S. PALMER. Letter in *J. Appl. Phys.*, **23**, 289–90 (*Feb.*, 1952).

Discussion on the experimental results of the field patterns due to $\lambda/2$ dipole using plane electromagnetic waves at 8 cm and 800 cm. Z. F. WOJNAR

538.566.2 : 621.396.11

4489. On the reflection of plane electromagnetic waves in slightly inhomogeneous layers. G. ECKART. *Arch. elekt. Übertragung*, **5**, 555–60 (*Dec.*, 1951) *In German.*

A theoretical treatment of the reflection of waves in a layer where the permittivity varies slightly in a direction perpendicular to the boundaries of the layer. The case of both monochromatic waves and pulses is considered using a method due to Schelkunoff. The author concludes that it is not practicable to use experimental data on pulse shape to deduce the variation of permittivity in the layer which caused the reflection. J. M. HOUGH (R)

538.566.2 : 621.396.11

4490. Volume integration of scattered radio waves. A. H. LAGRONE. *Proc. Inst. Radio Engrs*, **40**, 54 (*Jan.*, 1952).

The general equation for radio scattering developed by Booker and Gordon (1950) is extended to a volume integral equation.

538.566.2 : 621.396.11

4491. Oblique reflexion of radio waves by way of a triangular path. J. H. MEEK. Letter in *Nature* [*Lond.*] **169**, 327 (*Feb.* 23, 1952).

Abnormal traces on a vertical incidence (h', f)

record are attributed to oblique reflections from E_s clouds. Changes in the traces have been used to estimate the rate of movement of the clouds.

W. J. G. BEYNON

538.566.3

4492. Long-distance communication over north-south paths on 50 Mc/s. E. P. TILTON. *Mixed Commission on Ionosphere, Brussels* (1950) 119–20. [See Abstr. 4798 (1952)].

Amateur radio transmission observations in the 50 Mc/s band during the sunspot cycle peak 1947–48 show that no communication between S. America and points above latitude 40°N was possible except on days following ionospheric disturbances.

W. J. G. BEYNON

538.566.3

4493. Ionospheric wave propagation at low frequencies. J. FEINSTEIN. *Mixed Commission on Ionosphere, Brussels* (1950) 166–75. [See Abstr. 4798 (1952)].

The wave theory of l.f. propagation is discussed and curves presented indicating the divergence between ray and wave theory with respect to group height of reflection and reflection coefficient.

W. J. G. BEYNON

538.566.3 : 621.396.11

4494. Radio-wave propagation at oblique incidence including the Lorentz polarization term. J. M. KELSO. *Proc. Inst. Radio Engrs*, **40**, 87–97 (*Jan.*, 1952).

The application of the Lorentz theory of dispersion to some problems in the theory of the propagation of radio waves incident obliquely on a plane ionosphere is considered. The true height of reflection, ray path, reflection coefficient, range in the ionosphere, and group path in the ionosphere are studied without introducing the effect of the earth. For both a plane- and curved-earth geometry, ground range, group path, reflection coefficient as a function of the ground range, and the maximum usable frequency are determined. The following restrictions apply to the material presented: (1) all limitations on the Chapman distribution hold; (2) the earth's magnetic field is neglected; (3) the angular operating frequency is assumed to be greater than the collisional frequency wherever appreciable absorption occurs; (4) the absorption per vacuum wavelength is assumed to be small; and (5) ray theory is used. A.

538.566.3 : 621.396.11

4495. The ionospheric propagation of radio waves of frequency 16 kc/s over distances of about 200 km. R. N. BRACEWELL. *Instn Elect. Engrs Monogr. No.* 34, 12 *pp.* (*April* 15, 1952) [To be published also in *Proc. Instn Elect. Engrs, Pt IV*, 99].

The detailed information previously obtained at Cambridge of the propagation of waves of frequency 16 kc/s over a distance of 90 km has been extended by investigation of distances up to 200 km. Measurement of phase, the essential feature of the experiments, was achieved by comparison with a reference signal sent from the transmitter to the receiver by land line. Behaviour over the two ranges is much the same, the chief difference being that multiple reflections are more evident over the greater distance. The background common to this and companion papers is presented. A

538.567 : 621.385.1.029.

4496. Travelling-wave tubes. R. KOMPFNER. *Rep. Phys. Soc. Progr. Phys.*, **15**, 275–327 (1952).

The "wave" may be propagated along a retarding structure such as a helix or a corrugated waveguide or it may be a space-charge wave in a second electron stream. The history of the discovery and development is traced and a simple theory of operation outlined. A more complete theory according to J. R. Pierce is sketched by which can be calculated the effects of attenuation, of non-synchronous velocities and of space-charge effects. Recent developments relevant to the helix-type tube are described, such as "Brillouin"-focusing of electron streams in axial magnetic fields, or noise properties of electron streams. Other forms described include Millman's space-harmonic type of tube operating as amplifier at a wavelength of 6 mm, the electron-wave tube and the travelling-wave magnetron amplifier which combines the high efficiency of the magnetron with its amplifying function. Extensive bibliography. A.

MAGNETIC EFFECTS 538.6

538.63

4497. Galvanomagnetic effects in conductors. D. K. C. MACDONALD AND K. SARGINSON. *Rep. Phys. Soc. Progr. Phys*, **15**, 249–74 (1952).

The primary emphasis is on metals (including a short section on ferromagnetics), but reference is also made to semiconductors. For convenience the article is broadly divided, first, into a physical survey and, in the second part, a more mathematical treatment of some of the major problems involved; on account of the breadth of the field no claim to completeness is made. 86 refs. A.

538.632 : 539.4.016

Influence of cold-work on the Hall effect of a metal. *See Abstr.* 4678

538.652

4498. The measurement of the saturation magnetostriction at high temperatures. W. SUCKSMITH. *Rep. Brit. Elect. Res. Ass., Ref. N/T51*, 5 *pp.* (1950).

The main constructional features of an apparatus capable of measuring the magnetostriction of short ferromagnetic specimens in fields up to 3000 oersted at temperatures up to 600°C are described. Measurements of the magnetostriction of Ni and of 15% Mo–Fe alloys for 3 different heat treatments are given and discussed.

538.652

4499. The approach to saturation magnetostriction of nickel. E. W. LEE. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 162–3 (*Feb.*, 1952).

Experiments on a pure Ni strip indicate that the field dependence of the magnetostriction coefficient in high fields is $\lambda = \lambda_s(1 - aH^{-2}) + bH$, where a, b are constants and λ_s the pseudo-saturation value.

E. P. WOHLFARTH

538.653.1 : 538.247

4500. Mechanical Barkhausen effect. T. KAMEI. *J. Phys. Soc. Japan*, **6**, 260–5 (*July–Aug.*, 1951).

Experiments were carried out on the discontinuous magnetization changes (due to irreversible 90° boundary motion) in an iron single crystal under continuously varying external tension. Positive and negative magnetization changes occur, and over any extended range these cancel, as the crystal cannot be magnetized by mere application of stress. At the same time the crystal undergoes irreversible elongation, in addition to ordinary elastic strain. For the [100] direction these irreversible changes commenced for tensions > about 150 g mm^{-2} and were almost, but not quite, complete for tensions > about 400 g mm^{-2}. The total relative change of length was about 10×10^{-6}, most of which persisted after reducing the stress to zero. E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

4501. Energy of a Bloch wall on the band picture. I. Spiral approach. C. HERRING. *Phys. Rev.*, **85**, 1003–11 (*March* 15, 1952).

It is shown that the band or itinerant electron model of a solid is capable of accounting for the "exchange stiffness" which determines the properties of the transition region, known as the Bloch wall, which separates adjacent ferromagnetic domains with different directions of magnetization. In this treatment the constant spin function usually assigned to each running electron wave is replaced by a variable spin function. At each point of space the spin of a moving electron is inclined at a small velocity-dependent angle to the mean spin direction of the other electrons, and this gives rise to an exchange torque which makes the spin direction of the given electron precess as it moves through the transition region, the precession rate being just sufficient to keep it in approximate alignment with the macroscopic magnetization. Physical insight into the mechanisms involved is provided by a rigorous solution of the wall problem for a ferromagnetic free electron gas in the Slater–Fock approximation, although it is known that the free electron gas is not likely to be ferromagnetic in higher approximations. Rough upper limits to the exchange stiffness constants for actual ferromagnetic metals can be calculated without using any empirical constants other than the saturation moment and the lattice constant. The results are only a few times larger than the observed values.

A.

539.11

4502. Some generalized order–disorder transformations. R. B. POTTS. *Proc. Camb. Phil. Soc.*, **48**, 106–9 (*Pt* 1, 1952).

Kramers and Wannier's method (1941) for deriving the inversion transformation for the square Ising lattice, in which each unit is capable of 2 configurations ($r = 2$) is extended to the cases of $r = 3$ and $r = 4$. The case $r = 3$ is a particular case of a more general problem of r kinds of units in equal abundance.

A. J. KENNEDY

539.11

4503. A calculation of the cohesive energies and pressure/volume relations of the divalent metals. S. RAIMES. *Phil. Mag.*, **43**, 327–37 (*March*, 1952).

A method is described for calculating the energy of the lowest state ψ_0 of a divalent metal. This approximates to the well-known cellular method, but assumptions made regarding ψ_0, together with the use of a single empirical ionization potential, render unnecessary the explicit calculation of an ion-core field. An expression for the total energy of the valence electrons is obtained, the free-electron approximation being used tentatively in evaluating all terms except the energy of the lowest state, and this is then applied to the calculation of the atomic radii, compressibilities, and cohesive energies of the divalent metals. The change of volume for a range of pressures up to 100 000 kg/cm^2 is also calculated and found to be in good agreement with the experimental data of Bridgman. A.

MOLECULAR STRUCTURE 539.13

539.13

4504. Convergence of intermolecular force series. F. C. BROOKS. *Phys. Rev.*, **86**, 92–7 (*April* 1, 1952).

The commonly used perturbation method of estimating the Van der Waals forces between atoms is shown to lead, when carried to the extreme, to divergent results. The method employs an expansion of the classical electrostatic interaction between the atoms in a series of inverse powers of the internuclear distance. The divergence arises because this expansion is utilized in regions of configuration space where it is not convergent. In this paper, the resulting divergent intermolecular force series are shown to be asymptotic to the true molecular interaction. The divergence is removed in an approximate way and the second-order attractive energy so obtained is added to the first-order exchange energy between the atoms. The method results in an electronic energy curve for H_2^+ in reasonable accord with the exact result of Hylleraas and in a new interaction between helium atoms in good agreement with recent low temperature. A.

539.132

4505. Contribution to the study of the relations between interatomic forces and the electronic structure of polyatomic molecules. J. DUCHESNE. *Mem. Acad. Roy. Belg. Cl. Sci.*, **26**, 43 *pp.* (*No.* 7, 1952) *In French.*

A critical survey of the influence of resonance, hybridization, and van der Waals interactions. Semi-empirical examination of variations in bond lengths and force constants suggests that the influence of resonance is negligible, that hybridization of the central (carbon) atom is in part adequate, but that

hybridization of the bonding orbital of the atom linked to this central atom must in general be invoked to give a complete explanation of the experimental facts. H. H. GREENWOOD

539.132

4506. The use of isotopic molecules for the complete determination of force constants. I. Linear molecules. J. C. DECIUS. *J. Chem. Phys.*, **20**, 511–16 (*March*, 1952).

Equations are developed which show the maximum amount of information which can be obtained concerning the force constants with isotopic linear molecules. It is demonstrated that a unique solution can be found in terms of the expressions $\Sigma_k\lambda_k$, $\Sigma_k\lambda_k^2$ and $\Sigma_k\lambda_k^3$ where $\lambda_k = 4\pi^2\nu_k^2$, provided the ν_k are known for the "unsubstituted" molecule and for certain isotopic molecules involving respectively single, double and triple substitutions; i.e, if $ABCD\cdots$ is the unsubstituted molecule, isotopic molecules of the types $A^*BCD\cdots$, $AB^*CD\cdots$, etc., $A^*B^*CD\cdots$, etc., and $A^*B^*C^*D\cdots$, etc., are required. More than two isotopic forms (such as A and A^*) of any given atom are not required. For the triatomic molecule, only the singly substituted forms are required (this is also true for the perpendicular vibrations of the tetratomic molecule). It is also found that the force constants of the symmetrical linear molecule may be found using only symmetrical isotopic molecules; the number of these required is naturally less than the number required for an unsymmetrical molecule having the same number of atoms. A.

539.132

4507. The dissociation energy of SnO. G. DRUMMOND AND R. F. BARROW. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 148–9 (*Feb.*, 1952).

Comparison of thermochemical and spectroscopic evidence suggests that the products of dissociation of the state E are $Sn(^3P_2) + O(^3P)$. $D_0'' = 121$ kcal. R. F. BARROW

539.132

4508. Potential constants for diacetylene. S. M. FERIGLE, F. F. CLEVELAND AND A. G. MEISTER. Letter in *J. Chem. Phys.*, **20**, 526 (*March*, 1952).

On the basis of new Raman and infrared measurements the new potential constant for the central bond is 6·63; wave numbers calculated with these constants give excellent agreement with observed values. J. JACOBS

539.132

4509. Binding energies of gaseous alkali hydrides. W. A. KLEMPERER AND J. L. MARGRAVE. Letter in *J. Chem. Phys.*, **20**, 527 (*March*, 1952).

Good agreement with experiment is obtained for binding energies treating each molecule as consisting of ions, each polarized in the electrostatic field of the other. For gaseous alkaline earth oxide molecules, and for binding energies of HF, HCl, the method is utterly inadequate. J. JACOBS

539.132

4510. Study of the binding energies in aliphatic amines by mass spectrometry. J. COLLIN. *Bull. Soc. Roy. Sci. Liège*, **20**, 707–10 (*Dec.*, 1951) [*French.*

Upper limits of binding energies are calculated on the basis of mass-spectrometric measurements for CH_3NH_2, $C_2H_5NH_2$ and n . $C_7H_9NH_2$. The value obtained for n . $C_3H_7NH_2$ are stated to be unreliable. Probable errors are given. A. J. TAYLOR

539.133

4511. Hindering barriers of ethyl alcohol. K. ITO. Letter in *J. Chem. Phys.*, **20**, 531 (*March*, 1952).

The gas imperfection correction for entropy uses vapour pressure and observed heat of vaporization. With suitable internal rotation parts of entropy reasonable values for hindering barriers are obtained. J. JACOBS

539.133

4512. On vibrational transition probabilities in electronic transitions. K. E. SCHULER. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 70 (*Jan.*, 1952).

The variation with internuclear distance r of the electronic moment integral may be more important than the use of more exact wave functions. J. JACOBS

539.132

4513. Theory of resonance topology of fully aromatic hydrocarbons. I. M. GORDON AND W. H. T. DAVISON. *J. Chem. Phys.*, **20**, 428–35 (*March*, 1952).

The computation of resonance forms of any specified number of unpaired electrons ("radicality") of aromatic hydrocarbons is reduced to combinatorial problems, many of which can be solved on the basis of 5 simple lemmas. In this paper, only unexcited (Kekulé) forms are computed. Algorithms are deduced for deriving the number N of such forms for classes covering practically all nonreticulate aromatic hydrocarbons and a number of singly, doubly, or triply infinite series of reticulate ones. One lemma leads to a simplification of the combinatorial problems from the hexagonal to the square lattice ("dot diagrams"). Points of purely mathematical interest arise and may merit further study. A.

539.132

4514. Hybridization and molecular structure. J. DUCHESNE. Letter in *J. Chem. Phys.*, **20**, 540 (*March*, 1952).

The principle "hybridization of an atomic orbital of an atom varies with the hybridization of the C atom to which the atom is attached" is closely verified for CH_3CCH, CF_3CCH. J. JACOBS

539.132

4515. The electronic structure of diamond. G. G. HALL. *Phil. Mag.*, **43**, 338–43 (*March*, 1952).

The theory of equivalent orbitals is used to consider the electronic structure of diamond. The description in terms of equivalent orbitals is closely related to the usual chemical description since each orbital is localized and corresponds to one of the CC bonds. The Bloch orbitals can be expressed exactly as transforms of these equivalent orbitals. This leads to a new and more accurate method of determining the Bloch orbitals and their energies. For diamond, it is found that the energies can be expressed as an explicit function of the co-ordinates in reciprocal space. The results are compared with those obtained by Kimball, using the cell method, and the agreement is good.

This method has the advantage of relating the valence description of diamond directly with the zone description. A.

539.132

4516. Homopolar and metallic binding in diamond. K. GANZHORN. Note in *Naturwissenschaften*, **39**, 62 (*No.* 3, 1952) *In German.*

Energy bands and wave functions of the diamond crystal are calculated by the perturbation method, based on hybrids of hydrogen-like atomic wave functions. The results are compared with those found by the method of Hund and Mrowka (1935) and Kimball (1935). For diamond, both methods give identical results. A. J. TAYLOR

539.132 : 541.127

4517. Correlation of Hammett's σ-values with electron densities calculated by molecular orbital theory. H. H. JAFFÉ. *J. Chem. Phys.*, **20**, 279–85 (*Feb.*, 1952).

It is shown that Hammet's σ-values (constants correlating reaction rates and equilibrium constants of a large number of side-chain reactions of *meta*- and *para*-substituted aromatic compounds) can be correlated with electron densities calculated by the MO LCAO method. Since Coulomb and exchange integrals for atoms other than carbon are not accurately known, an absolute calculation of σ's is not possible. Nevertheless, σ-values permit derivation of a self-consistent and reasonable set of parameters which can be used to calculate reasonable values for absorption frequencies, mesomeric moments and orienting power of the substituents. A.

539.133

4518. An electron diffraction investigation of the structures of the aminodiboranes $(CH_3)_2NB_2H_5$ and $H_2NB_2H_5$. K. HEDBERG AND A. J. STOSICK. *J. Amer. Chem. Soc.*, **74**, 954–8 (*Feb.* 20, 1952).

The structures of N-dimethylaminodiborane, $(CH_3)_2NB_2H_5$ and aminodiborane, $H_2NB_2H_5$, have been investigated by electron diffraction in the gases. The results are in accord with symmetrical structures having fourfold co-ordination about the nitrogen atom, and may be considered as derived from the diborane (B_2H_6) structure by the simple replacement of a bridge hydrogen atom with the NR_2 group. A.

539.133

4519. The structure and internal motion of 1, 2-dichloroethane. J. AINSWORTH AND J. KARLE. *J. Chem. Phys.*, **20**, 425–7 (*March*, 1952).

The structure and internal motion of 1, 2-dichloroethane were investigated by means of electron diffraction. Values were obtained for several distances involving hydrogen atoms. In addition, the average amplitude of vibration was found for many of the distances. The predominant isomer was in the *trans*-form and the less abundant one was in the *gauche*-positions at 109 ± 5° from the *trans*-equilibrium position. The amount of *gauche*-isomer was found to be 27 ± 5% at 22°C. A.

539.133 : 535.343.4–14

4520. The microwave spectra of POF_3 and PSF_3. N. J. HAWKINS, V. W. COHEN AND W. S. KOSKI. Letter in *J. Chem. Phys.*, **20**, 528 (*March*, 1952).

Rotational transitions were observed for $PS^{32}F_3$, $PS^{34}F_3$, $PO^{16}F_3$ and $PO^{18}F_3$. Assuming the FPF angles given by electron diffraction (100° in PSF_3 and 106° in POF_3) the distances are PS, 1·86; PF, 1·53; PO, 1·48; and PF, 1·52 Å in PSF_3 and POF_3; the dipole moments are 0·633 and 1·69 *D* respectively. D. H. WHIFFEN

539.133 : 548.737

4521. Molecular dimensions of phenazine. F. H. HERBSTEIN AND G. M. J. SCHMIDT. Letter in *Nature* [*Lond.*] **169**, 323–4 (*Feb.* 23, 1952).

Bond lengths and bond angles have been determined and are compared with theoretical values. A. R. STOKES

539.133

4522. Molar volumes of liquid deuterium and of a 1 : 1 mixture of tritium and deuterium, 19·5 to 24·5°K. E. C. KERR. *J. Amer. Chem. Soc.*, **74**, 824–5 (*Feb.* 5, 1952).

These have been measured over a temperature range 19·5 to 24·5°K. The results deviate from fitted equations by about 0·2%. A.

539.133

4523. Definition of monoelectronic additive polarizabilities in the molecular orbital theory. J. GUY AND M. HARRAND. *C.R. Acad. Sci.* [*Paris*] **234**, 716–18 (*Feb.* 11, 1952) *In French.*

A partial polarizability tensor is defined for each orbital; hence the mean polarizability of a molecule with single bonds only is the sum of mean polarizabilities of bonds and of internal electrons of atomic clouds. The anisotropy of molecules is deduced from the anisotropies of bonds and the geometric configuration of the molecule. J. JACOBS

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

4524. The coupling of nuclear surface oscillations to the motion of individual nucleons. A. BOHR. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **27**, 40 *pp.* (*No.* 14, 1952).

The classical theory of the surface oscillations of a liquid drop is summarized. For deformations of order 2, rotational and vibrational energies are separated and an expression for the angular momentum of the drop is derived. The equations are quantized, the stationary states classified and the symmetries of the wave functions are discussed. The motion of nucleons in a deformed nucleus is then considered and a description of the coupling to the surface oscillations is obtained by the addition of an appropriate interaction Hamiltonian. The strong coupling approximation is considered in more detail and is illustrated by numerical examples. W. J. SWIATECKI

539.152.1

4525. A preferred-number correction to the Bethe–Weizsäcker formula for the nuclear binding energies. A. H. WAPSTRA. *Physica*, **18**, 83–90 (*Feb.*, 1952).

It is investigated how far the Bethe–Weizsäcker

formula for the nuclear binding energies explains the details of the β-stability if terms are included taking into account the occurrence of nuclear shells. It is found that these bell-shaped additions to the binding energy about closed shells should have a height of about 6 MeV at their maximum, in order to explain the β-stability characteristics of the nuclei. A.

539.152.1

4526. Some regularities in nuclear energy levels. P. J. GRANT. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 150–1 (*Feb.*, 1952).

Out of 45 nuclei 38 (involving 140 levels) obeyed the integer rule of level spacing to 1–2%. The highest common factor of the excitation energies is a fairly smooth function of Z, with peaks near $N = 50$ and 82 in the case of even-even nuclei. W. J. SWIATECKI

539.152.1

4527. Symmetry effects on nuclear dipole radiation with application to a bound excited state of $_2He^4$. L. E. H. TRAINOR. *Phys. Rev.*, **85**, 962–72 (*March* 15, 1952).

The effect of nuclear symmetry properties on electric dipole transitions is investigated using the independent particle model and Wigner's theory of the symmetric Hamiltonian. Methods are given for the construction of completely symmetrized wave functions for the nuclear states on this model. Symmetry selection rules are found to operate, in addition to the usual selection rules, to reduce the amount of nuclear dipole radiation. A detailed study of the He^4 nucleus leads to the conclusion that if a resonant state at 21·6 MeV does exist with a strong dipole transition to the ground state, then a bound, excited state of the α-particle also exists. Spin-orbit and tensor forces are introduced to give a possible explanation of the angular distribution of γ-rays when protons are captured by tritium. A.

539.152.1

4528. Nonlinear meson theory for heavy nuclei. B. J. MALENKA. *Phys. Rev.*, **86**, 68–72 (*April* 1, 1952).

A potential well somewhat between a three-dimensional isotropic oscillator and a square well is determined by using a nonlinear meson theory for heavy nuclei in their ground states. The introduction of a phenomenological spin-orbit coupling is shown to group the energy levels obtained according to the magic numbers. Finally, it is shown that the existence of nuclear shell structure seems to imply a modification in the concept of constant nuclear density for heavy nuclei. A.

539.152.1

4529. Studies in *jj*-coupling. I. Classification of nuclear and atomic states. B. H. FLOWERS. *Proc. Roy. Soc. A*, **212**, 248–63 (*April* 22, 1952).

Stimulated by the many successes of the recent *jj*-coupling shell-model of nuclear structure which is based upon the assumption of strong spin-orbit coupling, the present work aims at obtaining allowed terms and energies of systems of many equivalent particles in *jj*-coupling for various types of two-body interaction. The methods of group theory are employed to enumerate and classify the states of the nuclear configuration $(l_j)^n$. Classification of states according to the irreducible representations of groups of linear transformations leads naturally to the introduction of certain quantum numbers which then characterize the states. Invariance under the group of unitary transformations in the space of the $2j + 1$ individual-particle functions introduces the isotopic spin, while invariance under the subgroup of symplectic transformations introduces the concepts of seniority and reduced isotopic spin. The complete classification and enumeration of the states of the nuclear configurations j^n, carried through for $j = \frac{3}{2}$, $\frac{5}{2}$ and $\frac{7}{2}$, is presented; the states of the corresponding atomic configurations are included, these being states of maximum isotopic spin. As a result of the classification, certain degeneracies observed in the energy matrix of the electrostatic interaction in *jj*-coupling are shown to be intimately connected with the properties of the symplectic groups. Finally, the spins of nuclear ground states are briefly discussed in the light of the *jj*-coupling shell-model. A.

539.152.1 : 539.165

4530. Nuclear shell structure and beta-decay. I. Odd *A* nuclei. M. G. MAYER, S. A. MOSZKOWSKI AND L. W. NORDHEIM. *Rev. Mod. Phys.*, **23**, 315–21 (*Oct.*, 1951).

A systematics is given of all transitions for odd-A nuclei for which sufficiently reliable data are available. The allowed or forbidden characters of the transitions are correlated with the positions of the initial and final odd nucleon groups in the nuclear shell scheme. The nuclear shells show definite characteristics with respect to parity of the ground states. The latter is the same as the one obtained from known spins and magnetic moments in a one-particle interpretation. A.

539.152.1 : 539.165

4531. Nuclear shell structure and beta-decay. II. Even *A* nuclei. L. W. NORDHEIM. *Rev. Mod. Phys.*, **23**, 322–7 (*Oct.*, 1951).

A systematics of the β-transitions of even-A nuclei is given. An interpretation of the character of the transitions in terms of nuclear shell structure is achieved on the hypothesis that the odd nucleon groups have the same structure as in odd-A nuclei, together with a simple coupling rule between the neutron and proton groups in odd-odd nuclei. A.

539.152.2

4532. Nuclear spin of $^{53}_{24}$chromium. B. BLEANEY AND K. D. BOWERS. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 1135–6 (*Dec.*, 1951).

Improved paramagnetic resonance techniques reveal 4 lines which confirm the value 3/2 for the nuclear spin. A magnetic moment of $0{\cdot}45 \pm 0{\cdot}1$ nuclear magnetons can be deduced under certain assumptions. W. J. SWIATECKI

539.152.2

4533. A few provisional conclusions from observations on alignment of cobalt nuclei. C. J. GORTER, H. A. TOLHOEK, O. J. POPPEMA, M. J. STEENLAND AND J. A. BEUN. *Physica*, **18**, 135–6 (*Feb.*, 1952).

From the observed anisotropy of the γ-ray emission of aligned Co^{60} the magnetic moment of this nucleus is estimated to be $3{\cdot}2$ nuclear magnetons. From the dependence of the anisotropy on a magnetic field it is concluded that the hyperfine splitting of Co^{59} in

he salt concerned is 0·13 cm^{-1} between consecutive evels. A.

539.152.2

4534. The nuclear gyromagnetic ratio of V^{50} and measurements on Rb^{85} and Cl^{35}. H. E. WALCHLI, V. E. LEYSHON AND F. M. SCHEITLIN. Letter in *Phys. Rev.*, **85**, 922 (*March* 1, 1952).

$\nu(V^{50})/\nu(D^2) = 0{\cdot}649527 \pm 0{\cdot}00007$. The moment of V^{50} is positive, its gyromagnetic ratio is $0{\cdot}55690 \pm 0{\cdot}00006$. Results for Rb^{85} and Cl^{35} are in agreement with previous measurements. L. PINCHERLE

539.152.2

4535. The magnetic moment of Zn^{67}. S. S. DHARMATTI AND H. E. WEAVER, JR. Letter in *Phys. Rev.*, **85**, 927 (*March* 1, 1952).

$\mu(Zn^{67}) = +0{\cdot}87378 \pm 0{\cdot}00013$ (no diamagnetic correction applied). The longitudinal and transverse relaxation times are approximately equal.

L. PINCHERLE

539.152.2

4536. The gyromagnetic ratios of Li^7, Na^{23}, Al^{27} and P^{31}. T. KANDA, Y. MASUDA, R. KUSAKA, Y. YAMAGATA AND J. ITOH. Letter in *Phys. Rev.*, **85**, 938 (*March* 1, 1952).

Values of ratios of gyromagnetic ratio of given nucleus to that of proton (without diamagnetic correction) are: Li^7, $0{\cdot}388637 \pm 0{\cdot}000010$; Na^{23}, $0{\cdot}264514 \pm 0{\cdot}000009$; Al^{27}, $0{\cdot}260579 \pm 0{\cdot}000008$; P^{31}, $0{\cdot}404804 \pm 0{\cdot}000010$. L. PINCHERLE

539.152.2

4537. The magnetic moment of K^{40} and the hyperfine structure anomaly of the potassium isotopes. J. T. EISINGER, B. BEDERSON AND B. T. FELD. *Phys. Rev.* **86**, 73–81 (*April* 1, 1952).

The nuclear magnetic moment and atomic hyperfine splitting of the rare K^{40} isotope were measured by the atomic beam magnetic resonance technique. Detection of K^{40} atoms, from a source of normal potassium, was achieved by employing a conventional surface ionization detector as the ion source for a mass spectrometer, and by utilizing an electron multiplier to count the K^{40} ions. By measuring the frequencies of appropriate lines in the Zeeman pattern, the nuclear moment was determined to be $\mu_I = -1{\cdot}2964 \pm 0{\cdot}0004$ nuclear magnetons. The hyperfine splitting in the ground state was redetermined, with higher precision than that of previous measurements, to be $\Delta\nu = 1285{\cdot}790 \pm 0{\cdot}007$ Mc/sec. The ratio of the nuclear g factors of K^{39} and K^{40} was measured directly by observing, in the same homogeneous magnetic field, H, the frequencies of two lines (a doublet) in the Zeeman spectrum of each isotope. The doublet separation of these lines is, in each case, proportional to $2g_I\mu_0 H$, so that the ratio of the doublet splittings yielded directly $|g(K^{40})/g(K^{39})| = 1{\cdot}24346 \pm 0{\cdot}00024$. From these results and from the previously measured $\Delta\nu(K^{39})$, the hyperfine structure anomaly of these K isotopes is

$$\{[2I(K^{40}) + 1]g(K^{40})\Delta\nu(K^{39})/[2I(K^{39}) + 1]g(K^{39})\Delta\nu(K^{40})\} - 1 = (0{\cdot}466 \pm 0{\cdot}019)\%.$$

The theory of the hyperfine structure anomaly, as developed by A. Bohr and V. F. Weisskopf, was applied to the interpretation of this result. The predictions of a number of specific models, previously suggested to account for the observed nuclear g factors, have been compared with this experiment and with previous results on the anomalies for the Rb and the abundant K isotopes. The "asymmetric core" model of A. Bohr gives the best over-all agreement, mainly on the basis of the $K^{41} - K^{39}$ anomaly. In general, all models which are, in their essential features, based on the independent-particle model with spin-orbit coupling, give predictions in fair qualitative agreement with the experiments. The contribution of K^{40} to the h.f.s. anomaly seems, however, to be (fortuitously) insensitive to the differences between the models investigated. A.

539.153

4538. Excitation of atoms by electron collision. II. H. HORIE. *J. Phys. Soc. Japan*, **6**, 215–22 (*July–Aug.*, 1951).

The procedure of Pt I (Abstr. 8902 (1951)] is applied to cases in which the electron configuration of the atom is changed by the excitation. The probabilities for excitation and ionization in l_1^n and some other typical configurations are worked out. Explicit tables for p^n and d^n configurations are given.

W. J. SWIATECKI

539.153

4539. Magneto-optic detection of radio-frequency resonance. S. RAMASESHAN AND G. SURYAN. Letter in *Curr. Sci.*, **20**, 264–6 (*Oct.*, 1951).

Order-of-magnitude calculations suggest that it should be possible to detect radio-frequency resonance of beams of atoms in a $^2S_{\frac{1}{2}}$ state by means of the change of magneto-optic rotation of light near an absorption band as the resonance frequency is crossed by changing the static field (*c.* 35 oersteds) or the radio-frequency (*c.* 100 Mc/s at 10 oersteds). D. H. WHIFFEN

539.153

4540. The hyperfine structure of sodium by a microwave absorption method. K. SHIMODA AND T. NISHIKAWA. *J. Phys. Soc. Japan*, **6**, 512–16 (*Nov.–Dec.*, 1951).

The hyperfine structure of the ground state $^2S_{1/2}$ of the sodium atom, Na^{23} ($I = 3/2$), was measured by a microwave absorption method by means of a Zeeman modulation spectrograph. Among seven lines of the Zeeman components, $F = 1 \rightarrow F = 2$, six lines have been observed since it is not affected by weak magnetic field. The hyperfine structure separation at zero magnetic field was obtained from the results, and it is $\Delta\nu = 1771{\cdot}70 \pm 0{\cdot}15$ Mc/s. This is in good agreement with the known value measured by the atomic beam magnetic resonance method in the Paschen–Back region. A.

539.153

4541. The even configurations $d^3 + d_s^2 + d_s^2$ of Th II. Y. EISENBERG. *Physica*, **18**, 177–81 (*March*, 1952).

The energy levels of the low even configurations $d^3 + d_s^2 + d_s^2$ of Th II are calculated in intermediate coupling with configuration interaction and compared with the experimental values. The agreement is satisfactory: the average error is less than 1% of the

width of the configurations. Also, the calculated Landé g-factors agree fairly well with the experimental values. A.

539.153

4542. Electrodynamic displacement of atomic energy levels. I. Hyperfine structure. R. KARPLUS AND A. KLEIN. *Phys. Rev.*, **85**, 972–84 (*March* 15, 1952).

The vacuum fluctuations of the photon and pair fields modify the interaction of an electron with an electromagnetic field. The effects on the energy levels are conveniently described in terms of the mass operator and the vacuum polarization potential. A gauge-covariant expansion of the mass operator for the motion of an electron in a weak external electromagnetic field is derived; the expression contains terms quadratic in the field but includes only the lowest order electrodynamic correction. The modification in the Fermi formula is then computed by specializing the external field to consist of the Coulomb and magnetic dipole fields of the nucleus and by taking the matrix element of the operators in an S-state of a hydrogen-like atom. All changes can be described as a correction $\Delta g = -2Z\alpha^2(5/2 - \ln 2)$ in the gyromagnetic ratio of the electron. The value of the fine structure constant deduced from measurements of the hyperfine structure becomes $\alpha^{-1} = 137{\cdot}0364$. A.

539.153.4 : 537.228.5

4543. On the Stark effect of helium in strong electric field. II. S. SUEOKA AND M. SATO. *J. Phys. Soc. Japan*, **6**, 444–51 (*Nov.–Dec.*, 1951).

For Pt I, see Abstr. 1722 (1951). To explain the resonance phenomena of the Stark lines of the He atom, a general method was found in Pt I to solve the secular equations, taking into account the matrix elements between the states with different principal quantum numbers, n and n'. On the lines of this general method, the numerical computations for ortho-helium were performed in the case of $n = 6$ and $n' = 7$. Numerical tables and diagrams representing the relations of the Stark energies and field strengths are obtained for the respective values of magnetic quantum numbers, $m = 1, 2, 3$ and 4. From these results the pairs of levels approaching nearest and repelling each other were found. A.

539.155.2

4544. Isotope separation by radiofrequency electric field. N. YAMAMURO. Note in *J. Phys. Soc. Japan*, **6**, 411–13 (*Sept.–Oct.*, 1951).

Ions are accelerated by a d.c. electric field (~ 300 V) through a gap, where a longitudinal r.f. field is applied (~ 200 V, 4 Mc/s), into a field-free drift space. Another r.f. gap, supplied from the same source, is followed by a variable d.c. retarding field and a collector. It is shown that only ions of a certain e/M can overcome a given retarding field and be collected. Mass spectra of Li isotopes are shown; $2{\cdot}7 \times 10^{-8}$ ampere of Li^7 ions were collected. T. G. PICKAVANCE

539.155.2

4545. Limits of isotopic abundance for [hypothetical stable isotopes of] hafnium and platinum. H. E. DUCKWORTH, R. F. WOODCOCK, G. S. STANFORD, A. COUTU AND R. L. STEARNS. Letter in *Phys. Rev.*, **85**, 929 (*March* 1, 1952).

539.155.3

4546. Isotope fractionation in the bacterial reduction of sulphate. H. G. THODE, H. KLEEREKOPER AND D. MCELCHERAN. Letter in *Research* [*Lond.*] **4**, 581–2 (*Dec.*, 1951).

Although under normal circumstances the sulphur isotopes do not exchange between sulphate and sulphide, it is found that some fractionation occurs when sulphates are reduced to sulphides by sulphur bacteria under anaerobic conditions. Reducing bacteria *Vibrio desulphuricans* is isolated in pure culture and runs carried out by inoculating 9 litres of a medium containing sulphate of known isotopic content; the H_2S formed is depleted in S^{34} by $\sim 1\%$. 5 refs. H. H. HODGSON

539.155.2

4547. Distribution of S^{34} in nature and the origin of native sulphur deposits. J. MACNAMARA AND H. G. THODE. Letter in *Research* [*Lond.*] **4**, 582–3 (*Dec.*, 1951).

From a table which gives the S^{32}/S^{34} ratios for native sulphur samples of known origin, this ratio is seen to vary by 4·5% with the sulphur of organic origin being depleted in S^{34} as compared with samples of volcanic origin. Figures are also included, whereby the distributions of S^{34} in natural samples of native sulphur, sulphates, igneous and meteoritic sulphurs and sulphides are compared, and the sulphur cycle in the sea is illustrated. The well defined isotopic separations between the sulphur samples of volcanic and organic origins may provide a method of determining the origin of natural sulphur deposits. H. H. HODGSON

539.155.4

4548. The atomic weight of silicon. J. F. NORTON AND P. D. ZEMANY. Letter in *J. Chem. Phys.*, **20**, 525 (*March*, 1952).

The value $28{\cdot}096 \pm 0{\cdot}004$ (physical) has been obtained from mass spectrometer measurements of the mass of Si^{28} (using 3 doublets with CO^+, N_2^+ and $C_2H_4^+$) and of the relative abundance of the Si isotopes. This is 0·1% higher than the currently accepted value. T. G. PICKAVANCE

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

4549. An accurate method for the measurement of radioiodine in the thyroid gland by an external counter. T. FIELDS AND G. V. LEROY. *Radiology*, **58**, 57–67 (*Jan.*, 1952).

The sources of error involved in making an absolute estimate of uptake of radioiodine in the thyroid gland by an externally located G.M. counter have been investigated. The measurement system used is considered to give results with an error of $\pm 10\%$ or less. The method has been used to measure uptake in 170 patients and the mean uptake figures at 24 hours are quoted as follows:—euthyroid subjects 21 $\pm$ 8%, hyperthyroids 73 $\pm$ 13% and hypothyroids 3 $\pm$ 3%. H. MILLER

539.16.08 : 778.3

4550. Use of nuclear plates for the determination of the uranium and thorium contents of radioactive ores. H. J. POOLE AND C. M. E. MATTHEWS. Letter in *Nature* [*Lond.*] **169,** 408–9 (*March* 9, 1952).

By placing a layer of crushed ore on the surface of a nuclear track plate and observing the ratio of the number of α-particle tracks whose ranges exceed that of radium C′ to the number of tracks whose ranges lie between that of radium C′ and radium A, the thorium–uranium ratio of the ore can be determined. The range measurements are simplified by counting only the horizontal tracks, and a thick layer of ore can be used. A. C. COATES

539.16.08 : 778.3

4551. The use of photographic emulsions in the study of radioactive solutions. M. ADER. Letter in *J. Phys. Radium,* **13,** 110–11 (*Feb.*, 1952) *In French.*

Thin-walled glass capillary tubes, free from potassium, are filled with the radioactive solution, placed on a glass plate and covered with liquid emulsion to give an emulsion thickness of 100–200 microns on drying. After processing, the tubes are surrounded by particle tracks, and only those tracks emitted normally to the tube and in the plane of the emulsion are counted. The method has the advantage that the properties of the emulsion are unaltered by the introduction of the capillary tubes. Several long-range particles from Po have been observed, and these are described in detail in another paper (see abstract following). A. C. COATES

539.16.08 : 778.3

4552. Study of the radiation from polonium sources using photographic plates. M. ADER, J. DEBIESSE AND T. KAHAN. *C.R. Acad. Sci.* [*Paris*] **234,** 827–8 (*Feb.* 18, 1952) *In French.*

The emission of long range particles from polonium sources has been studied by the nuclear plate method and by the capillary tube method (see preceding abstract). Two types of polonium sources have been used, an electrolytic deposit of polonium and a solution of a polonium salt. The results indicate that the long-range particles are protons, and the number emitted is proportional to the strength of the polonium source and the exposure time. The protons are produced by collisions in the source and have a maximum energy of 3·3 MeV. A. C. COATES

539.163

4553. Nuclear data. K. WAY, G. FULLER, M. WOOD, K. THEW AND A. JURGENS. *Circ. Nat. Bur. Stand.* [*Wash.*] *No.* 499 *Suppl. No.* 2, 52 *pp.* (1951).

See Abstr. 2938, 6402 (1951). This supplement covers information published between July 1950 and January 1951. The only major new class of information is a year's list of fission and spallation papers.

539.163

4554. Mass numbers of the 35-hr krypton and of the 50-hr arsenic activities. D. F. BRACHER AND A. R. CRATHORN. Letter in *Nature* [*Lond.*] **169,** 364 (*March* 1, 1952).

These activities are assigned to Kr^{79} and As^{71}. Isotopes produced by deuteron bombardment of Br and Ge were separated in a 90° mass spectrometer, the ions being driven into the collector by an additional accelerating potential of 30 kV. T. G. PICKAVANCE

539.163

4555. Search for natural radioactivity of calcium 48. J. W. JONES AND T. P. KOHMAN. Letter in *Phys. Rev.*, **85,** 941 (*March* 1, 1952).

Recent mass measurements indicate that the transition $Ca^{48} \rightarrow \beta^- \rightarrow Sc^{48}$ (½-life 44 hr) is probably exoergic. Sc^{48} activity was sought from 100 lb Ca nitrate, but none obtained. The min. ½-life for the decay is 2×10^{16} yr, so that $\log ft > 24{\cdot}8$, and the spin of Sc^{48} (an odd-odd nucleus) $\geqslant 5$. A. O. STANESBY

539.163.1

4556. The half-life of the 1·3 MeV excited state in K^{41}. L. G. ELLIOTT. Letter in *Phys. Rev.*, **85,** 942 (*March* 1, 1952).

β–γ coincidence measurements on A^{41} showed the ½-life of the 1·3 MeV excited state of K^{41} is $(6{\cdot}7 \pm 0{\cdot}5)\times10^{-9}$ sec; this is appreciably longer than the calc. value $(0{\cdot}45\times10^{-9}$ sec) for a magnetic quadrupole transition. A. O. STANESBY

539.163.2

4557. The radioactivity of potassium 40. C. F. G. DELANEY. *Sci. Proc. Roy. Dublin Soc.*, **25,** 251–94 (*Nov.* 12, 1951).

Using an end window G.M. counter the β-activity of K^{40} was determined as $31{\cdot}9 \pm 3$ β-particles/sec/g K, giving a ½-life for β-decay of K^{40} of $(1{\cdot}25 \pm 0{\cdot}13)\times10^9$ yr; the max. β-energy was determined from absorption in Al as $1{\cdot}65 \pm 0{\cdot}2$ MeV. Possible decay schemes are discussed. A. O. STANESBY

539.163.2

4558. Arsenic 79. P. J. VAN DER HAACK, A. E. DE VRIES AND A. H. W. ATEN, JR. Letter in *Physica,* **18,** 20 (*Jan.*, 1952).

Ten-minute As^{79}, having a maximum β-energy of 2·1 MeV and no detected γ-rays, was identified in Se compounds irradiated with fast neutrons and deuterons. J. J. WILKINS

539.163.2

4559. The radioactive decay of Hg^{197} and Hg^{203}. J. M. CORK, D. W. MARTIN, J. M. LEBLANC AND C. E. BRANYAN. Letter in *Phys. Rev.*, **85,** 386–7 (*Jan.* 15, 1952).

Hg^{203}, with a ½-life of $47{\cdot}9 \pm 0{\cdot}2$ days, emits a single γ-ray of 279·5 keV. A new level scheme is given for Hg^{197}, which was shown to have 2 isomeric states. A. O. STANESBY

539.163.2

4560. Spontaneous fission rates. W. J. WHITEHOUSE AND W. GALBRAITH. Letter in *Nature* [*Lond.*] **169,** 494 (*March* 22, 1952).

Plots are made of log (spontaneous fission rate) against Z^2/A for (A even, Z even), (odd, odd) and (odd, even) nuclei. For (even, even) nuclei the points (except U^{234}) lie on a straight line; the spontaneous fission rates for (odd, odd) and (odd, even) nuclei are less by several powers of 10, but the points appear to lie on two curves, the rates for (odd, even) nuclei being in general lower than those for (odd, odd) nuclei. A. O. STANESBY

539.163.2

4561. The nuclear spectrum of Ge^{77}. A. B. SMITH. *Phys. Rev.*, **86**, 98–101 (*April* 1, 1952).

The disintegration of Ge^{77} (12 hour) has been studied with the help of a magnetic lens spectrometer, coincidence counters and scintillation counters. The β-ray spectrum consists of three groups whose end-point energies are 2·196 MeV, 1·379 MeV and 0·710 MeV. In addition there are 13 γ-rays appearing in the product nucleus As^{77}, some of which are internally converted. By coincidence counting techniques it has been shown that the β-ray of energy 2·196 MeV does not go to the ground state but to an excited state 0·264 MeV above the ground state. A disintegration scheme is suggested. A.

539.164

4562. On the Geiger–Nuttall relation. T. SEXL. *Acta Phys. Austriaca*, **5**, 258–62 (*No.* 2, 1951) *In German.*

It is found that the wave-mechanical theory of α-decay gives a linear relation between $\ln \lambda$ and $(Z-2)/v$ (v = velocity of the α-particle) instead of the G–N relation. J. HUGHES

539.164

4563. The α-spectra of the reactions $Li_3^8(\ ,\beta)2\alpha$ and $B_5^{11}(p,\alpha)2\alpha$ and the possibilities of tripartition of the compound nucleus C_6^{12*}. R. CHASTEL. *C.R. Acad. Sci.* [*Paris*] **234**, 522–3 (*Jan.* 28, 1952) *In French.*

The difficulties in the interpretation of the above α-spectra suggest the possibility of tripartition of C^{12*} in the reaction $B^{11}(p,3\alpha)$. W. J. SWIATECKI

539.164 : 539.166

4564. Fine structure and angular correlation in Po^{210}. S. DE BENEDETTI AND G. H. MINTON. Letter in *Phys. Rev.*, **85**, 944 (*March* 1, 1952).

Low-energy α-particles were detected in coincidence with the weak 0·8 MeV γ-rays. Angular correlation measurements were consistent with a $\sin^2 2\theta$ distribution. J. J. WILKINS

539.165

4565. Decay of Au^{198}. L. SIMONS AND E. P. TOMLINSON. *Comment. Phys.-Math.*[*Helsingf.*] **16**, 10 *pp.* (*No.* 6, 1952).

The β-spectrum of Au^{198} obtained by neutron irradiation of Au was investigated in a double-focusing β-spectrometer at a resolving power of 0·5%. The max. energy is 0·965 ± 0·005 MeV, and the Fermi plot is straight down to 0·4 MeV. The level scheme and spin assignation of the product nucleus Hg^{198} are discussed. A. O. STANESBY

539.165

4566. High energy components of the β-particle spectrum of $MsTh_2$. C. G. CAMPBELL, W. J. HENDERSON AND J. KYLES. *Phil. Mag.*, **43**, 126–7 (*Jan.*, 1952).

Evaporated sources of the nitrates of $MsTh_2$ with Ce were examined in a semicircular β-spectrometer using an anthracene scintillation detector. The spectrometer was calibrated against the β-end-point of ThC (2·256 MeV). Absence of the ThB *F*-line and correct rate of decay, indicated freedom from thoron decay products. The Fermi plot gave a maximum energy of 2·16 ± 0·03 MeV with evidence of partial spectra having end points of 1·85 ± 0·1 MeV, 1·6 ± 0·1 MeV and possible lower energ groups. L. R. SHEPHER

539.16

4567. A search for double beta-decay in palladium R. G. WINTER. Letter in *Phys. Rev.*, **85**, 687 (*Feb.* 1 1952).

Radiations from ~250 g Pd were examined in Wilson cloud chamber; 1 photograph (out of ~10 showed 2 connascent electron tracks, which migh however, have been produced by a cosmic γ-ray. Thi upper limit of the ½-life of Pd for the double β-deca is ~ 10^{18} yr. A. O. STANESB

539.16

4568. The low energy beta-ray spectrum of ^{170}Tm. R. RICHMOND AND H. ROSE. *Phil. Mag.*, **43**, 367–7 (*March*, 1952).

A thin magnetic lens β-ray spectrometer in con junction with a coincidence circuit employing a pai of photomultipliers was used to examine the low energy β-ray spectrum of Tm^{170}, which was expected to exhibit a forbidden shape. The spectrum was however, found to have an allowed shape. The results may best be interpreted on the assumption that the transition is first forbidden with axial vector or tenson interaction, the latter interaction being slightly favoured. A.

539.165

4569. The average energy of beta-ray spectra. R. S. CASWELL. *Phys. Rev.*, **86**, 82–5 (*April* 1, 1952).

The average β-energy per disintegration has been measured for P^{32}, Y^{90}, I^{131} and Ca^{45}. An air-filled water-electrode extrapolation ionization chamber was used for measurement of the rate of emission of energy. The absolute disintegration rate was determined by 4π-counting. Good agreement was found between the measured average energy values and values predicted by the Fermi theory using maximum energy data from the literature. Experimental results obtained were P^{32}, 0·696 ± 0·03 MeV; Y^{90}, 0·895 ± 0·035 MeV; I^{131}, 0·189 ± 0·008 MeV (includes conversion electrons); and Ca^{45}, 0·0746 ± 0·003 MeV. A.

539.165 : 537.533.72

4570. Investigation of the radiation from Ra(B + C) by means of the trochoid method. P. M. WEINZIERL. *Acta Phys. Austriaca*, **5**, 185–8 (*No.* 2, 1951) *In German.*

The source was a Rn-filled glass tube set normal to the median plane and just outside the circumference of circular pole pieces. Film diametrically opposite recorded radiation of apparent $H\rho$ ~1000 gauss cm; but 2·6 g cm^{-2} Pb did not stop it completely. This tends to confirm Thibaud's "Electrino" experiments [Abstr. 1640 (1948), 286 (1949)]. J. C. E. JENNINGS

539.165 : 537.533.7

Determination of beta-ray end-point energies by absorption. *See Abstr.* 4393

539.165.

4571. Theoretical discussion of the beta decay of ^{32}P. D. L. PURSEY. Letter in *Proc. Phys. Soc.* [*Lond.*] *A* **64**, 1138–9 (*Dec.*, 1951).

It is shown that the contradiction between th allowed shape and long lifetime of P^{32} can be accounte

r on the basis of the single particle model using the thor's calculations [Abstr. 1204 (1952)]. The sirability of measuring the spin of P^{32} is stressed.

W. J. SWIATECKI

539.165.2

572. **The upper limit for the neutrino rest mass.** . KOFOED-HANSEN. *Phil. Mag.*, **42**, 1448–50 (*Dec.*, 951).

The theoretical β-spectrum formula contains a arameter ("b") depending on the coupling assumed ich that the "E_{max}" of a Fermi plot obtained by inear extrapolation is no longer a direct measure of $_\nu$. This leads to a more conservative estimate of he upper limit for m_ν (~ 5 keV) using the data of lanna and Pontecorvo [Abstr. 6397 (1949)].

W. J. SWIATECKI

539.165.2

573. **A theorem involving binding energies in elation to β-disintegration.** N. FEATHER. *Phil. Mag.*, 3, 133–5 (*Jan.*, 1952).

The difference between the β-energies of 2 nuclei s written approximately in terms of n and p binding nergies only. Applied to disintegration data it uggests a quantitative similarity in the effects on isintegration energies of the shells at $Z = 82$ and $N = 126$.

W. J. SWIATECKI

539.165.2

574. **First-forbidden beta-decay matrix elements.** . AHRENS AND E. FEENBERG. *Phys. Rev.*, **86**, 64–8 *April* 1, 1952).

The general theory of first forbidden beta-transiions involves seven nuclear matrix elements in the onrelativistic approximation. In principle the umber of independent parameters can be reduced to our with the help of the relation $(W_f - W_i)(f|X|i) = f|[H_0, X]|i) + (f|[H_c, X]|i) + (f|[H_\nu, X]|i)$. Here W s an energy eigenvalue, X a coordinate type first-orbidden operator, H_0 the free particle Hamiltonian, H_c the Coulomb interaction, and H_ν the specifically uclear interaction. The commutators of H_0 and H_c with X are easily evaluated, but $[H_\nu, X]$ presents difficulties. However, the matrix elements of $[H_\nu, X]$ an be estimated by general physical arguments based on the semi-empirical energy surface and the validity of shell model considerations. The explicit form of H_ν is not required, a fortunate circumstance since H_ν or complex nuclei is at present essentially unknown. hese calculations determine the common proporionality factor Λ in the relations $\frac{1}{2}\Lambda\alpha Z\int \mathbf{r}/R = -i\int\boldsymbol{\alpha}$, $\frac{1}{2}\Lambda\alpha Z\int\boldsymbol{\sigma}\cdot\mathbf{r}/R = -i\int\gamma_5$, $\frac{1}{2}\Lambda\alpha Z\int\boldsymbol{\sigma}\times\mathbf{r}/R = -\int\beta\boldsymbol{\alpha}$. A.

539.166

575. **Neutron capture γ-rays from phosphorus, ulfur, chlorine, potassium, and calcium.** B. B. KINSEY, G. A. BARTHOLOMEW AND W. H. WALKER. *Phys. Rev.*, **85**, 1012–23 (*March* 15, 1952).

The prominent capture γ-rays were studied with he aid of a pair spectrometer. The neutron binding nergies obtained for P^{32}, S^{33}, Cl^{36} and K^{40} are $7{\cdot}94 \pm 0{\cdot}03$, $8{\cdot}64 \pm 0{\cdot}02$, $8{\cdot}56 \pm 0{\cdot}03$ and $7{\cdot}77 \pm 0{\cdot}03$ MeV. Neutron capture in P produces a compliated spectrum in which the ground-state γ-ray is weak. Most of the captures in S occur in S^{32} and produce S^{33} in a cascade process involving the fifth excited state near 3·2 MeV. The direct transition to the ground state in S^{33} is weak. In Cl the ground state γ-ray and those produced by transitions from the capturing state to the first six excited states in Cl^{36} are of comparable intensity. In K there are relatively strong transitions to the ground state and to the second excited state of K^{40}. Some of the γ-rays produced by K can be identified with transitions in K^{42}, the excited state at 2·3 MeV being favoured above all others. Three very weak γ-rays have been detected with energies above that to be expected from capture in K^{39} and K^{41}. These γ-rays do not appear to be due to impurities. It is possible that they arise from the capture of neutrons by K^{40} and, if this hypothesis is correct, that isotope must have a large capture cross-section for thermal neutrons. In C the greater part of the γ-ray spectrum can be fitted into the energy level system of Ca^{41}. No γ-ray corresponding to the ground-state transition in Ca^{41} was detected. A.

539.166

4576. **Low energy γ-transitions in some rare earth isotopes.** J. W. MIHELICH AND E. L. CHURCH. Letter in *Phys. Rev.*, **85**, 690–1 (*Feb.* 15, 1952).

Internal conversion spectra of the γ-transitions following the β-decay of Nd^{147}, Dy^{165}, Ho^{166}, Tm^{170} and Lu^{176*} were examined in a permanent-magnet 180° spectrograph. Relative intensities of the conversion lines were determined by photographic densitometry, and transition multipolarities are assigned. A. O. STANESBY

539.166

4577. **Study of the 350 keV γ-transition accompanying the α-emission AcC → AcC″.** J. TEILLAC, P. FALK-VAIRANT AND C. VICTOR. *C.R. Acad. Sci.* [*Paris*] **234**, 1051–2 (*March* 3, 1952) *In French.*

The internal conversion coefficient was determined from measurements of α-conversion-electron coincidences; the γ-ray is mixed magnetic dipole-electric quadrupole. A. O. STANESBY

539.166 : 537.542

Scintillation counter as gamma ray spectrometer. *See Abstr.* 4426

539.166.7

4578. **The ratio of *K* and *L* photoelectric absorption of gamma rays.** N. MARTY. *C.R. Acad. Sci.* [*Paris*] **234**, 938–9 (*Feb.* 25, 1952) *In French.*

Measurements were made of the ratio τ_L (cross-section for photoelectric absorption in the L-shell)/τ_K (cross-section for photoelectric absorption in the K-shell) for γ-rays of 0·411 (Au^{198}) and 0·140 MeV (Tc^{99*}), using absorbers of U, Pb, Au and Ag; the values are compared with theory [*Rev. Mod. Phys.*, 8, 358–97 (*Oct.*, 1936)]. A. O. STANESBY

539.166.74

4579. **Forward scattering of light by a Coulomb field.** F. ROHRLICH AND R. L. GLUCKSTERN. *Phys. Rev.*, **86**, 1–9 (*April* 1, 1952).

The complex scattering amplitude for the scattering of light by a Coulomb field (Delbrück scattering) in the forward direction is calculated exactly by two methods. First, the Feynman method is used and necessitates very tedious and complicated calculations. Then, the method of analytical continuation is applied to the pair production cross-section and yields the

same result much more easily. An exact analytical expression is obtained for the dispersive and absorptive parts of the amplitude. The result is plotted as a function of energy. The low energy limit agrees with previous calculations for this limit by Kemmer and Ludwig. A.

539.166.74

4580. Small angle scattering of light by a Coulomb field. H. A. BETHE AND F. ROHRLICH. *Phys. Rev.*, **86**, 10–16 (*April* 1, 1952).

The angular distribution for small angles and the total cross-section for Delbrück scattering (the elastic scattering of γ-rays by the Coulomb field of heavy nuclei) are calculated approximately. The method is a combination of an impact parameter and an analytic continuation method. It is valid for energies $\hbar\omega$ large compared to the electron rest energy mc^2. Curves are given for the shapes of the dispersive and absorptive parts of the differential cross-section, valid for angles of order $mc^2/\hbar\omega$ or less. A.

539.166.83

4581. Interference in the directional correlation of conversion electrons. J. W. GARDNER. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 1136–8 (*Dec.*, 1951).

It is pointed out that the absence of interference in conversion-conversion and conversion-γ correlations derives from the assumptions that the conversion electrons are ejected from an *s*-state and that a non-relativistic treatment is justified. W. J. SWIATECKI

539.166.83

4582. Secondary electron emission and effective atomic numbers. G. J. HINE. *Nucleonics*, **10**, 9–15 (*Jan.*, 1952).

The measurement of forward and backscattered secondary electrons produced by γ-radiation incident upon various materials of different Z, has been carried out using thin-walled ionization chambers to detect the emitted electrons. γ-rays from Ra, Na^{24}, Co^{60}, Zn^{65}, Cs^{134}, Cu^{61} and Au^{198} were employed. The backscattering from materials with Z up to 40, increases linearly with log $(Z + 1)$ and the forward emission shows a corresponding decrease. Above $Z = 40$ both forward and backward emission show a marked increase with increasing Z due to photo-electrons, this effect being greatest for the lowest-energy γ-rays. Expressions are derived for the "effective" atomic numbers of substances containing several elements, for γ-ray absorption by photo-electron and pair production and for backscattered electron emission. The experimental determination of effective atomic number for backscattered electron emission using photographic emulsions to measure the latter is described. The values determined in this way for $CaCO_3$ and NaCl are in good agreement with those calculated. A measured value of $\bar{Z}_{back} = 11{\cdot}5 \pm 0{\cdot}5$ was obtained with dry bone.

L. R. SHEPHERD

539.166.83

4583. Fine structure in the U^{238} decay. B. ZAJAC; N. MILLER. Letters in *Phil. Mag.*, **43**, 264–6 (*Feb.*, 1952).

Ilford G5 emulsions were impregnated with natural U, purified from its decay products, as the complex ammonium citrate at pH8. It is estimated that $(23 \pm 3)\%$ of U^{238} α-disintegrations are ass
ciated with an L or $(M + N)$ internal conversi
transition of total energy 48 keV. Appendix dea
with the use of citrate as a complexing agent f
heavy metals in the neutral solutions required
maintain the electron sensitivity of nuclear emulsio
(see also abstract following). A. O. STANESB

539.166.

4584. The internal conversion radiation of U^2 G. ALBOUY AND J. TEILLAC. *C.R. Acad. Sci.* [*Pari*
234, 829–30 (*Feb.* 18, 1952) *In French.*

Electron tracks associated with α-particles we
observed in Ilford G5 emulsions impregnated with
(as uranium nitrate in 5% acetic acid, or as uran
carbonate). The measurements suggest that th
electrons are due to the conversion of a γ-ray
~ 50 keV and intensity 0·24/disintegration, in agree
ment with the results of Zajac (preceding abstract).

A. O. STANESB

539.166.8

4585. Auger enhancement of the $M\alpha$ X-ray satelliti lines. F. R. HIRSCH, JR. Letter in *Phys. Rev.*, **85**
685 (*Feb.* 15, 1952).

A photometric analysis of the plates of F. R
Hirsch, Jr (1931) shows a complete absence of shar
satellites due to Auger broadening. A quantitativ
analysis of the intensities agrees with predictions o
Coster and Kronig [*Physica*, **9**, 84 (1942)].

W. J. SWIATECK

539.166.83

4586. Measurement on the *I*, *F* and *A* lines o thorium by a new method. H. CRAIG. Letter in *Phys. Rev.*, **85**, 688 (*Feb.* 15, 1952).

Using a line image of a line source in a lens spectro
meter, comparative determinations of the specific
momenta of internal conversion lines may be made
with considerable accuracy; absolute values are
obtained using X-ray measurements of binding
energies, and for the *I*, *F* and *A* lines of Th are
$1753{\cdot}9 \pm 0{\cdot}4$, $1388{\cdot}5 \pm 0{\cdot}3$ and $533{\cdot}66 \pm 0{\cdot}12$
gauss-cm respectively. A. O. STANESBY

539.166.83

4587. Internal conversion in the *L*-shell. H.
GELLMAN, B. A. GRIFFITH AND J. P. STANLEY. Lette
in *Phys. Rev.*, **85**, 944 (*March* 1, 1952).

Tables are given of internal conversion coefficient
for electric dipole, electric quadrupole and magneti
dipole radiation, relative to the L_I, L_{II} and L_{III} level
of the elements 92, 84 and 49 for three γ-ray energies

L. PINCHERL

539.167.

4588. Radioisotypes production in the Unite States. P. C. AEBERSOLD AND A. F. RUPP
Nucleonics, **10**, 24–7 (*Jan.*, 1952).

A short account of the production of radioisotope
in nuclear reactors and the problems of processin
them, particularly in the case when the radioactiv
substances are handled in the fluid form.

L. R. SHEPHER

539.167.

4589. Automatic sample separator for radioactiv liquids. A. E. BENNETT. *Nucleonics*, **10**, 14–1
(*Feb.*, 1952).

An ion exchange process is used, the mixed fissio

oducts being taken up by the resin after which the olumn is washed out by an eluting agent, the various oducts flowing out in turn according to the strength their bond to the exchange material. The activity the effluent is monitored by a G.M. counter which, s each fission product is evolved, diverts the flow to a collecting bottle. When the activity falls again e flow is diverted to waste and a new bottle is moved to place. A liquid-level monitoring device ensures at no bottle can overflow; 36 sample bottles are arried on an endless chain. The peaks in effluent tivity which correspond to the collected samples are ecorded. L. R. SHEPHERD

NUCLEAR REACTIONS 539.17

539.17

590. Industry—the atom and nuclear power. T. K. LENNAN, G. DEAN AND J. COCKCROFT. *Nucleonics*, **0,** 16–23 (*Jan.*, 1952).

General account of the problems and aims of he American and British atomic energy projects.

L. R. SHEPHERD

539.17

591. Preparation of tritium–zirconium targets. . S. ROCHLIN. Note in *Rev. Sci. Instrum.*, **23,** 00–1 (*Feb.*, 1952).

Thick targets were made by bonding a Zr foil to W backing disk, then heating in T gas. A stainless teel oven containing U served to purify, pump and tore the T. Typical targets had a H isotope/Zr tomic ratio of 0·8. Details of the technique are given. F. R. HOLT

539.17 : 523.877

Thermonuclear reactions and astrophysics. *See Abstr.* 4116

539.17 : 537.521.7

An attempt to produce a thermonuclear reaction by means of a high-current spark discharge. *See Abstr.* 4370

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 4445, 4455–9

539.172 : 537.591.8

4592. Investigation into the higher moments of a nucleon cascade. L. JÁNOSSY AND H. MESSEL. *Proc. Roy. Irish Acad. A*, **54,** 245–62 (*No.* 16, *May*, 1951).

See also Abstr. 6447 (1951). The development of a cascade in an absorber composed of discrete nuclei is analysed, using a generalization of the *G*-equation of L. Jánossy [Abstr. 4336 (1950)]. The 2nd moment of the distribution is greater than for a cascade in homogeneous nuclear matter. There is a great similarity in the results for 1st and 2nd moments with electron–photon cascades. W. J. SWIATECKI

539.172

4593. On the disintegration of beryllium with mesons. A. P. ZHDANOV, P. I. LUKIRSKIĬ AND Z. S. SOKOLOVA. *Dokl. Akad. Nauk SSSR*, **80,** 729–30 (*No.* 5, 1951) *In Russian.*

If 2 out of 3 observed photographs of a π^--meson stopping and producing one heavily ionizing disintegration track in a Be-loaded emulsion are interpreted as $Be^9 + \pi^- = Li^7 + 2n^1$, then the observed energy of Li^7 is such that its recoil momentum can only be balanced by the 2 neutrons going off together as a di-neutron. The other photograph is taken to be $Be^9 + \pi^- = Li^6 + 3n^1$. W. J. SWIATECKI

539.172.13

4594. The angular distribution of neutrons produced in beryllium by 170 MeV protons. M. SNOWDEN. *Phil. Mag.*, **43,** 285–8 (*March*, 1952).

The angular distribution of high-energy neutrons produced by bombarding a beryllium target with the 170 MeV proton beam of the Harwell cyclotron has been measured. The angular spread for neutrons with energies greater than 50 MeV was found to be 67° at half intensity and in this spread the higher energy neutrons were shown to be confined to the smaller angles. The total cross-section for the production of neutrons with energies greater than 50 MeV was found to be $99 \pm 40 \times 10^{-27}$ cm², while the differential cross-section at 4° was $69 \pm 30 \times 10^{-27}$ cm²/steradian. A.

539.172.13

4595. Capture gamma-rays from 277-keV protons on N^{14}. C. H. JOHNSON, G. P. ROBINSON AND C. D. MOAK. Letter in *Phys. Rev.*, **85,** 931–2 (*March* 1, 1952).

γ-rays produced by the resonance capture of 277 keV protons by N^{14} were examined using a NaI(Tl) scintillation counter, and evidence of 6 obtained: *A*, $0{\cdot}75 \pm 0{\cdot}03$; *B*, $1{\cdot}39 \pm 0{\cdot}03$; *C*, $2{\cdot}38 \pm 0{\cdot}10$; *C′*, $5{\cdot}29 \pm 0{\cdot}10$; *B′*, $6{\cdot}21 \pm 0{\cdot}10$ and *A′*, $6{\cdot}84 \pm 0{\cdot}10$ MeV; these probably form three 2-γ cascade processes *AA′*, *BB′* and *CC′* with a total energy of 7·60 MeV. *B* and *B′* are certainly to be assigned to N: the weaker groups *AA′*, *CC′* may be due to target contamination. No direct transition to the ground state was found. A. O. STANESBY

539.172.13

4596. Neutrons and gamma-rays from the proton bombardment of beryllium. T. M. HAHN, C. W. SNYDER, H. B. WILLARD, J. K. BAIR, E. D. KLEMA, J. D. KINGTON AND F. P. GREEN. Letter in *Phys. Rev.*, **85,** 934 (*March* 1, 1952).

The *n* and γ-ray yields in the forward direction from the *p* bombardment of Be were extended to a max. *p* energy of 5·3 MeV; a new peak was found in the γ-yield curve at $E_p = 4{\cdot}72 \pm 0{\cdot}01$ MeV (width $\sim 0{\cdot}5$ MeV at ½ max.), in addition to the known level of $2{\cdot}57 \pm 0{\cdot}01$ MeV. A. O. STANESBY

539.172.13

4597. High energy nuclear physics at Harwell. T. G. PICKAVANCE AND J. M. CASSELS. *Nature* [*Lond.*] **169,** 520–3 (*March* 29, 1952).

A review of experiments using protons and neutrons produced by the 110-in Harwell cyclotron.

T. G. PICKAVANCE

539.172.13

4598. Inelastic scattering of deuterons. R. HUBY AND H. C. NEWNS. Letter in *Phil. Mag.*, **42,** 1442–5 (*Dec.*, 1951).

A theoretical explanation is proposed for earlier reported experiments [e.g. Abstr. 8218 (1951)], which show a peculiar angular distribution. It assumes that only one constituent of the deuteron

interacts with the nucleus. Information about spins and parities of nuclear states can be deduced.

F. R. HOLT

539.172.13

4599. Deuteron reactions with separated magnesium isotopes. J. AMBROSEN. Letter in *Nature* [*Lond.*] **169,** 408 (*March* 8, 1952).

The energies of protons emitted at 90° to a 1·9 MeV deuteron beam falling on Mg samples were detected in Ilford emulsions. Four, six and two energy groups respectively were found in the 3 cases: $Mg^{24, 25, 26}(d, p)\,Mg^{25, 26, 27}$. W. J. SWIATECKI

539.172.13

4600. The *D–D* cross-section and angular distribution below 50 keV. J. MOFFATT, D. ROAF AND J. H. SANDERS. *Proc. Roy. Soc. A,* **212,** 220–34 (*April* 22, 1952).

The cross-section and angular distribution of the protons from the *d–d* reaction were studied with bombarding energies between 15 and 50 keV using a thin gas target. The cross-section results show a significant deviation from the simple Gamow theory of penetration through a Coulomb barrier. Both this deviation and the asymmetry of the reaction at even the lowest energies can be explained consistently by the contribution to the reaction of waves of non-vanishing angular momentum. Analysis of the results in terms of such waves gives some indication that spin-orbit coupling is a significant factor in the transitions. A.

539.172.13

4601. Reactions induced by tritons in photographic emulsions. P. CÜER AND D. MAGNAC-VALETTE. *C.R. Acad. Sci.* [*Paris*] **234,** 1049–51 (*March* 3, 1952) *In French.*

A detailed study of nuclear emulsions loaded with Li and exposed to a flux of tritons has put in evidence the stages of the following 3 new reactions: $Li^6(t, n)2He^4$, $Li^7(t, 2n)2He^4$ and $N^{14}(t, p, n)N^{15}$ as well as the predominance of 3-body disintegrations and the production of neutrons. W. J. SWIATECKI

539.172.3

4602. High energy photodisintegration of the deuteron. T. S. BENEDICT AND W. M. WOODWARD. Letter in *Phys. Rev.*, **85,** 924 (*March* 1, 1952).

Differential cross-sections for proton emission have been measured at γ-ray energies from 80 to 160 MeV, showing marked departures from calculated values.

J. J. WILKINS

539.172.3

4603. Relative probabilities of diverse photonuclear reactions from Zn^{64} and Fe^{54}. R. SAGANE. Letter in *Phys. Rev.*, **85,** 926 (*March* 1, 1952).

(γ, n), (γ, pn), $(\gamma, 2n)$ and $(\gamma, 2np)$ cross-sections have been measured and show that the total γ-absorption cross-section falls off above 20 MeV. Some results on Al^{27}, Ge^{70}, Ni^{58} and Mo^{92} are included. J. J. WILKINS

539.172.3

4604. The photodisintegration of the deuteron, and the measurement of γ-ray energies with photographic emulsions containing heavy water. W. M. GIBSON, T. GROTDAL, J. J. ORLIN AND B. TRUMPY. *Phil. Mag.*, **43,** 457–66 (*April,* 1952).

Photographic plates soaked in heavy water have been used in a study of the photodisintegration of deuterons by γ-rays of energy 6·1 and 7·0 MeV. The principles of the method were described in an earlier paper [Abstr. 5775 (1951)], but the technique has been improved and the accuracy of the results increased. The method has been shown to be valuable for the measurement of γ-ray energies in the interval 4–12 MeV. The accuracy obtained at 6 MeV is about 40 keV, while γ-ray lines with an energy difference of 0·4 MeV could be resolved. The angular distribution of the protons has been measured, and the values $a/b = 0{\cdot}05 \begin{cases} +0{\cdot}03 \\ -0{\cdot}02 \end{cases}$ and $k = 0{\cdot}02 \pm 0{\cdot}08$ have been obtained for the constants in the equation $\sigma(\phi) = a + b \sin^2\phi(1 + k \cos \phi)$. The value of a/b is lower than that found by Goldhaber, but no exact theoretical values are available for comparison. A.

539.172.3

4605. Nuclear photodissociation by high energy synchrotron gamma-rays. S. KIKUCHI. *Phys. Rev.*, **86,** 41–51 (*April* 1, 1952).

The stars and single proton tracks produced in photographic emulsions exposed to a beam of high-energy synchrotron γ-rays were analysed. The maximum energy of the bremsstrahlung spectrum was varied between 150 and 300 MeV. The following subjects were studied: the cross-section for star production as a function of the excitation energy; the energy distribution of the protons from stars as well as single protons; the angular distribution of star protons as well as single protons; the relative number of stars associated with a meson coming out. The cross-section for the nuclear photoevents increases with increasing energy above the meson threshold. There seem to be two sorts of processes taking place in competition with each other. One is the so-called free meson effect; namely, a free meson is produced inside the nucleus by the interaction of a photon with a nucleon and is then absorbed in the same nucleus. The other effect is a process in which a photon is absorbed directly by a group of nuclear particles without emitting a real meson. Evidence for the free meson effect is seen in the fact that the angular distribution of star protons of energy between 20 and 60 MeV in the case of 300 MeV excitation shows a strong forward peak. Evidence for the existence of the direct absorption of photons comes from the fact that the angular distribution of star protons of high energy, say about 100 MeV, shows a forward asymmetry. The cross-section for direct absorption is much larger than expected from Levinger's theory of nuclear photodissociation. The cross-section should be at least of the same order of magnitude as the free meson effect. A.

539.172.4

4606. Fast protons from 270-MeV *n–d* collisions. J. B. CLADIS, J. HADLEY AND W. N. HESS. *Phys. Rev.*, **86,** 110–17 (*April* 1, 1952).

The differential cross-section for production of high-energy protons in *n–d* scattering, using the 270 MeV neutron beam of the 184 in cyclotron, has been measured at scattering angles between 4° and 58°. For normalization, yields of protons from *n–p*

attering were measured at each scattering angle. n all cases, only protons above a cut-off energy of 0 MeV $\cos^2\Theta$ were accepted by the counter system. n addition, through the use of a magnetic analyser, nergy distributions of the *n–d* protons were measured t 4° and 22·5°. The energy distributions closely esembled, in shape, the energy distributions of *n–p* rotons at the same angles, confirming the similarity n nature between collisions of high-energy neutrons ith free protons and collisions with protons bound n deuterium. Total yield of protons above the cut-off nergy is lower for *n–d* than for *n–p* collisions, how-ver, the ratio of the two being about 0·7 at all ngles observed. Effects of the exclusion principle, f the internal momentum distribution of the deuteron, nd of the difference in average potential energy etween the dineutron and the deuteron are discussed s possible causes of the lowering of the *n–d* proton ield below that from *n–p* scattering. A.

539.172.4

4607. Fission and the shell model of atomic nuclei. . Meitner. *Ark. Fys.*, **4**, 383–6 (*Paper* 20, 1952) *In ierman.*

A review of the data on the mass division in low- nd high-energy fission, with special reference to the symmetry observed in the former case and the uthor's interpretation of this in terms of the extra tability of fragments with closed shells [Abstr. 288 (1950)]. W. J. SWIATECKI

539.172.4

4608. Spontaneous fission. E. Segrè. *Phys. Rev.*, **6**, 21–8 (*April* 1, 1952).

Summarizes part of the work on spontaneous uclear fission performed at Los Alamos before 1945. he experimental technique used to detect spontane- ous fission in the heavy α-active elements is described, nd the decay constants for spontaneous fission bserved in a number of substances are listed. The umber of neutrons emitted per spontaneous fission f U^{238} was also measured and found to be $2\cdot2 \pm 0\cdot3$. A.

539.172.4

4609. Neutrons from the spontaneous fission of horium. F. R. Barclay, W. Galbraith and W. J. Whitehouse. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **5**, 73 (*Jan.*, 1952).

The rate of emission of spontaneous fission neutrons rom Th has been compared with that from U using ight $B^{10}F_3$ counters embedded in a cube of paraffin ax as neutron detector. It was found that the ratio f neutron emission from U to that from Th is 153 ± 10. Comparing this with the known ratio of he fission rates 164 ± 13 it is deduced that $\nu_{Th}/\nu_U = 1\cdot07 \pm 0\cdot10$. L. R. SHEPHERD

539.172.4

4610. Nomogram for calculating fission-product ctivities. L. G. Stang, Jr and P. D. Hance, III. *Nucleonics*, **10**, 48–9 (*Jan.*, 1952).

The activity of any given primary fission product n Curies/g of U can be obtained, given the irradiation ime, thermal neutron flux, half-life of the isotope in uestion and its percentage yield in U^{235} fission. The nomograph can be used also to calculate the yield of secondary or higher products, provided that their half-lives are much longer than those of their precursors. L. R. SHEPHERD

539.172.4

4611. Heavy-water reactor at Kjeller, Norway. O. Dahl and G. Randers. *Nucleonics*, **9**, 5–17 (*Nov.*, 1951).

This reactor, similar in basic design to the Chalk River and Châtillon reactors, consists of a cylindrical aluminium tank, 2 m dia., containing 7 tons of heavy water and 2·2 metric tons of U, surrounded by a graphite reflector and concrete shield. The U rods, 25·4 mm dia. by 30 cm, are packed into Al tubes 1·9 m long which are suspended vertically, parallel to the axis of the tank. The reactor is controlled by 4 Cd plates, 130 cm × 35 cm, which slide between the heavy water tank and the graphite reflector. The heat generated is dissipated by passing the heavy water through a tap-water-cooled heat exchanger, the tap water thence circulating to a second heat exchanger where it is air cooled. The average heavy-water temperature rises to about 40°C at an operating power of 100 kW. Experimental holes and a graphite thermal column pass through the shield, and Al tubes running through the tank provide irradiation facilities. A central neutron flux of 3×10^{11} $n/cm^2/sec$ is available at 100 kW. L. R. SHEPHERD

539.172.4

4612. Uses and limitations of a low-power nuclear reactor. C. K. Beck. *Nucleonics*, **9**, 18–27 (*Nov.*, 1951).

A brief review of the research value of low-power nuclear reactors, describing their use as sources of active isotopes, including fission products and as sources of neutrons and γ-radiation for experiments in radiation chemistry, physics and biology. L. R. SHEPHERD

539.172.4

4613. The G.L.E.E.P. as an absolute standard of thermal neutron density. D. J. Littler, E. E. Lockett and B. T. Price. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **64**, 1139–40 (*Dec.*, 1951).

The neutron density at the centre of the low-energy pile at Harwell can be maintained at a reproducible value between 10 n/cm^3 and 2×10^4 n/cm^3, with the help of a boron coated ion chamber using a 5–100 MΩ wire wound resistor and a potentiometer for current measurement. The absolute values of neutron densities have been measured by β-counting of activated 1/*v* absorbers, Na and Mn, irradiated in Gleep and Bepo. L. R. SHEPHERD

539.172.4

4614. Canadian facilities for isotope production and bombardment. F. W. Gilbert. *Nucleonics*, **10**, 6–8 (*Jan.*, 1952).

A maximum neutron flux of more than $5 \times 10^{13} n/cm^2/sec$ is available in the heavy-water-moderated natural uranium NRX pile at Chalk River. The advantage of a high flux for producing radioactive isotopes with high specific activity and for producing successive transformations, e.g. $Na^{23}(n, \gamma)Na^{24}(n, \gamma)Na^{25}$ is outlined. Diagrams are

given showing the neutron flux distribution and the neutron economy of the reactor. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS. NEUTRONS 539.18

539.18

4615. Pair creation by mesons. W. THIRRING. *Proc. Roy. Irish Acad. A*, **54**, 205–16 (*No.* 14, *July*, 1951).

The creation of pairs through virtual photon emission when a ps. scalar meson with vector coupling is absorbed by a nucleus is compared with real photon emission using covariant perturbation methods of Schwinger, Dyson and Feynman. Both cross-sections go to ∞ with decreasing meson velocity, the former being even bigger, due to its greater statistical weight of final states. W. J. SWIATECKI

539.18

4616. Multiple creation of mesons. D. IVANENKO AND V. LEBEDEV. *Dokl. Akad. Nauk SSSR*, **80**, 357–60 (*No.* 3, 1951) *In Russian.*

In analogy with hypotheses about "electron–neutrino forces" [Ivanenko and Sokolov (1936), Ivanenko (1938)] a phenomenological theory of nucleon–meson interaction is proposed in which the interaction energy is a sum of terms each corresponding to direct coupling to states containing 1, 2, 3, . . . n mesons. Multiple production of mesons then follows in lowest-order perturbation theory. A numerical application is compared with observed photographic stars, As regards the effect on nuclear forces, such a theory would lead to a potential behaving like $r^{-(2n-1)}$ at the origin. W. J. SWIATECKI

539.18

4617. Neutral meson production in energetic nuclear encounters. A. LOVATI, A. MURA AND G. TAGLIAFERRI. Letter in *Nuovo Cim.*, **9**, 205–7 (*Feb.*, 1952).

More complete statistics on the production of penetrating particles (mostly $\pi^{\pm}$) and electronic showers (associated with π^0) in Pb plates in a cloud chamber suggest that the ratio of the production rates of π^0 to $\pi^{\pm}$ mesons is 0·3–0·5. W. J. SWIATECKI

539.18

4618. Phenomena associated with negative μ-mesons stopped in photographic emulsions. W. F. FRY. Letter in *Phys. Rev.*, **85**, 676 (*Feb.* 15, 1952).

A total of 1008 μ^--meson endings in electron-sensitive emulsions were analysed. Stars were produced by 3·1 ± 0·6% of the stopped mesons. The ratio of the stopping power per atom of Ag or Br to the average stopping power in gelatin for low energy mesons was deduced to be 4·8. W. J. SWIATECKI

539.18

4619. Photomeson production in carbon and hydrogen. B. T. FELD, D. H. FRISCH, I. L. LEBOW, L. S. OSBORNE AND J. S. CLARK. Letter in *Phys. Rev.*, **85**, 680 (*Feb.* 15, 1952).

The energy spectra of photomesons produced in paraffin and graphite were measured by plate technique at 90° and 26° to the X-ray beam produced by 330-MeV electrons. Agreement with experiments of Steinberger and Bishop [Abstr. 6736, 7512 (1950)] and ps. scalar theory of Feshbach and Lax [Abstr. 509 (1950)]. W. J. SWIATECKI

539.1

4620. Photomeson production from deuterium. I. E. LEBOW, B. T. FELD, D. H. FRISCH AND L. S. OSBORNE. Letter in *Phys. Rev.*, **85**, 681 (*Feb.* 15, 1952).

Using the technique reported in the preceding abstract the average π^-/π^+ yield ratio was found to be 0·5 ± 0·5 at 90° and 0·90 ± 0·23 at 26°. The observed ratio of photoproduction of π^+ from D and H, together with previous measurements, suggests a large spin-dependent interaction when interpreted in terms of phenomenological theories of Chew and Lewis [Abstr. 2111 (1952)] and Feshbach and Lax [Abstr. 3772 (1951)]. W. J. SWIATECKI

539.1

4621. Is there a neutral μ-meson? G. E. UHLENBECK and C. S. W. CHANG. Letter in *Phys. Rev.*, **85**, 684 (*Feb.* 15, 1952).

The compatibility of present data on the β-spectrum of μ^--decay with the scheme $\mu^- \rightarrow \mu^0 + e^- + \nu$ ($m_{\mu^0} \sim 40\,m$) is illustrated. The possible analogy between π^{+-0} and μ^{+-0} suggests the process $\mu^0 \rightarrow \nu + \gamma + \gamma$. W. J. SWIATECKI

539.18

4622. Scattering of 50-MeV positive pions by helium. A. M. THORNDIKE, E. C. FOWLER, W. B. FOWLER AND R. P. SHUTT. Letter in *Phys. Rev.*, **85**, 929 (*March* 1, 1952).

A total of 15 nuclear interactions and 345 π–μ decays in flight were observed in 3400 pictures using a diffusion cloud chamber filled with 15 atmos. of He and methanol vapour. W. J. SWIATECKI

539.18

4623. Total cross section of negative pions in hydrogen. H. L. ANDERSON, E. FERMI, E. A. LONG, R. MARTIN AND D. E. NAGLE. Letter in *Phys. Rev.*, **85**, 934 (*March* 1, 1952).

Observations in the range 80–230 MeV were taken, using a pion beam monitored by two 1-in square scintillation crystals and measuring the attenuation on passing 7½ in liquid H by recording coincidences of further scintillators. The cross-section rises rather rapidly to the "geometrical" value $\pi(\hbar/\mu c)^2$ at 150 MeV; then it levels off. W. J. SWIATECKI

539.18

4624. Ordinary and exchange scattering of negative pions by hydrogen. E. FERMI, H. L. ANDERSON, A. LUNDBY, D. E. NAGLE AND G. B. YODH. Letter in *Phys. Rev.*, **85**, 935 (*March* 1, 1952).

Using a geometry similar to that reported in the preceding abstract but with a set of scintillators at 90° to the beam and a removable Pb radiator to increase their sensitivity to γ's, an attempt was made to distinguish between the 2 processes: $p + \pi^- \rightarrow p + \pi^-$ and $p + \pi^- \rightarrow n + \pi^0 \rightarrow n + 2\gamma$. Cross-sections of $10 \pm 4 \times 10^{-27}$ and $20 \pm 5 \times 10^{-27}$ cm² respectively can be deduced on certain assumptions about angular distribution, etc. W. J. SWIATECKI

539.18

4625. Total cross sections of positive pions in hydrogen. H. L. ANDERSON, E. FERMI, E. A. LONG AND D. E. NAGLE. Letter in *Phys. Rev.*, **85**, 936 (*March* 1, 1952).

Using the same technique as for π^- [Abstr. 4623 (1952)] a more rapid increase with energy was found. The results are compatible with a discussion in terms of the assumption that in the range investigated (50–150 MeV) the dominant interaction responsible for the scattering is through an intermediate level of isotopic spin 3/2. W. J. SWIATECKI

539.18

4626. Radiative π–μ decay. T. EGUCHI. Letter in *Phys. Rev.*, **85**, 943 (*March* 1, 1952).

A relativistic 2nd-order perturbation calculation of the probability for the decay of a scalar or ps. scalar into a Dirac μ, a neutral particle and a photon. The ratio of radiative to ordinary decay is $\sim 10^{-4}$ which is also the proportion of decays with an anomalously short μ track observed by Fry [Abstr. 4648–9 (1952)]. W. J. SWIATECKI

539.18

4627. Evidence for the existence of neutral particles of very short life-time. M. DANYSZ, W. O. LOCK AND H. YEKUTIELI. Letter in *Nature* [*Lond.*] **169**, 364–5 (*March* 1, 1952).

This comes from (1) the analysis of the energies of two π's ejected from a star at 155° to the vertical and 25° to one another; (2) statistics of π's ejected at $> 90°$ to the primary or of energies < 30 MeV; (3) directional correlation in 200 low multiplicity secondaries. The simplest explanation is in terms of a decay $\zeta^0 \rightarrow \pi^+ + \pi^- + Q$, where Q is a few MeV and ζ^0 has mass 556 m_e and life-time $< 10^{-14}$ sec. W. J. SWIATECKI

539.18

4628. On multiple creation of mesons in nucleon–nucleon collisions. M. TEUCHER. Note in *Naturwissenschaften*, **39**, 68–9 (*No.* 3, 1952) *In German.*

Example of a 5×10^{10}-eV star with the high number of 20 (charged) secondaries obtained in a balloon flight. W. J. SWIATECKI

539.18

4629. Remarks on the theory of the multiple creation of mesons. W. HEISENBERG. Note in *Naturwissenschaften*, **39**, 69 (*No.* 3, 1952) *In German.*

In view of the observations reported in the preceding abstract the existence of stars where, for the same primary energy, widely different numbers of secondaries are observed is pointed out, and interpreted as due to a dependence of the multiplicity on the impact parameter, the yield being greatest for head-on collisions. W. J. SWIATECKI

539.18

4630. Scattering and absorption of pi-mesons in carbon. H. BYFIELD, J. KESSLER AND L. M. LEDERMAN. *Phys. Rev.*, **86**, 17–21 (*April* 1, 1952).

The interactions of positive and negative pi-mesons of 62 MeV with carbon nuclei were studied in a magnet cloud chamber, using the external beams of the Nevis cyclotron. A Coulomb-nuclear interference is observed in the elastic scattering. This establishes that the nuclear potential is attractive for mesons. Nuclear cross-sections obtained are $\sigma_{abs} = 181 \pm 22$ mb, $\sigma_{el\ sc} = 148 \pm 30$ mb. A complex square well model for the nucleus is considered. A.

539.18

4631. Meson–nucleon scattering and nucleon isobars. K. A. BRUECKNER. *Phys. Rev.*, **86**, 106–9 (*April* 1, 1952).

The scattering (including charge exchange) of π^--mesons in hydrogen rises from 18 millibarns at 60 MeV to a broad plateau of about 60 millibarns at 200 MeV, and is smaller than the π^+ scattering at 60 MeV in the ratio of $0{\cdot}63 \pm 0{\cdot}09$. The general features of the π^- scattering, except for the high energy plateau, are given qualitatively by pseudoscalar theory with pseudovector coupling in the weak coupling limit; the ratio of π^- to π^+ scattering predicted by this theory in the weak coupling limit is, however, 1·67, which is much higher than the experimental result. A phenomenological theory of the scattering is developed by using the methods of Wigner and Eisenbud and imposing the restrictions of charge symmetry. By using the qualitative assignment of the resonance levels parameters as given by weak and strong coupling theory, satisfactory agreement with experiment is obtained. It is concluded that the apparently anomalous features of the scattering can be interpreted to be an indication of a resonant meson–nucleon interaction corresponding to a nucleon isobar with spin $\frac{3}{2}$, isotopic spin $\frac{3}{2}$, and with an excitation of 277 MeV. A.

539.185

4632. Electron–neutron interaction. G. BREIT. *Proc. Nat. Acad. Sci.* [*Wash.*] **37**, 837–46 (*Dec.*, 1951).

The explanation of this as advanced by Foldy [Abstr. 7534 (1951)] is analysed without the special canonical transformation of Foldy and Wouthuysen. The meaning of the Pauli magnetic moment term is illustrated by a consideration of special cases and of the equations of motion which show how the term corresponds to a classical magnetic doublet along the neutron spin. The interaction of the neutron moment with the divergence of the electric field is compared with a similar effect in the phenomenological treatment of the electron's magnetic moment. Assumptions sufficient for the applicability of Foldy's explanation independently of details of the origin of the neutron's magnetic moment are discussed. W. J. SWIATECKI

539.185

4633. The concept of the virtual level in the theory of the elastic scattering of neutrons on atomic nuclei. O. BERGMANN. *Acta Phys. Austriaca*, **5**, 240–53 (*No.* 2, 1951) *In German.*

The different definitions of a virtual level are discussed and their regions of validity analysed. Comparison with rigorous two-body solutions is made and the relation to the S-matrix is pointed out. Numerical examples are given for n–p scattering. W. J. SWIATECKI

539.185 : 548.7

4634. Multi-oscillator processes in the scattering of neutrons by crystals. G. L. SQUIRES. *Proc. Roy. Soc. A*, **212**, 192–206 (*April* 22, 1952).

The neutron velocity selector of the Cavendish Laboratory was used to investigate the variation of the scattering of slow neutrons with the temperature

of the scatterer. Results were obtained for Ni and Mg. Weinstock, in a theoretical treatment of this scattering [Abstr. 1161 (1944)] considers processes in which the neutron exchanges one or no phonons with the vibrations of the crystal lattice. The measured values of the cross-sections are found to be greater than those given by Weinstock's theory, the discrepancy reaching 30% for Mg at 625°K. A method of calculating the cross-sections for processes involving the exchange of more than one phonon is given in this paper, and it is shown that when these cross-sections are added to those given by Weinstock's theory, the results agree with experiment to within 4%. A.

539.185.08

4635. Slow neutron liquid scintillation detector. C. O. MUEHLHAUSE AND G. E. THOMAS. Letter in *Phys. Rev.*, **85**, 926 (*March* 1, 1952).

The esters: methyl, ethyl, propyl, etc., borate, when added to a standard fluorescent solution of phenylcyclohexane, terphenyl and diphenylhexatriene do not quench the fluorescence and so can be used for detecting slow neutrons at very high efficiencies.

W. J. SWIATECKI

539.185.08

4636. Measurement of neutron flux with lithium borate loaded emulsions. N. KAPLAN AND H. YAGODA. *Rev. Sci. Instrum.*, **23**, 155–61 (*April*, 1952).

Methods for the incorporation of lithium borate in nonelectron-sensitive nuclear emulsions have been investigated from the viewpoint of emulsion stability and high B^{10} and Li^6 pick-up for use in the estimation of low neutron flux. Ilford *C*-2 plates loaded by absorption from 10% lithium borate solution buffered with lithium carbonate and containing 3% by volume of glycerine or diethylene glycol pick-up an equilibrium concentration of 34 mg per ml of boron and 12 mg per ml of lithium ions, respectively. Isothermal absorption curves indicate that the borate and lithium ions migrate into the gelatin—AgBr mixture at different rates. Higher concentrations of B- and Li-nuclei in the emulsion can be introduced by the method of evaporation loading. Methods for evaluating the boron and lithium concentration in the emulsion are described. Quantitative recording of tracks from the $B^{10}(n, \alpha)Li^7$ and the $Li^6(n, \alpha)H^3$ reactions can be maintained for periods of about 3 months; which provides a convenient means of estimating low slow-neutron flux for purposes of health monitoring, or investigations of spontaneous fission processes, and for the evaluation of the cosmic radiation neutron background. The flux at sea level arising from cosmic radiation is of the order of 230 slow neutrons per cm^2 per day (ranging from 160 to 300 with change of exposure conditions). At an elevation of 3500 m, the flux shows a 10-fold increase.

A.

STRUCTURE OF SOLIDS 539.2

539.211

4637. Surface of finely-ground silica. P. B. DEMPSTER AND P. D. RITCHIE. Letter in *Nature* [*Lond.*] **169**, 538–9 (*March* 29, 1952).

The existence of a highly soluble surface layer on finely ground quartz particles is inferred fr differential thermal analysis measurements. Estima of the thickness of the layer are given. J. THEW

539.2

4638. Surface of finely-ground silica. G. NAGE SCHMIDT, R. L. GORDON AND O. G. GRIFFIN. Let in *Nature* [*Lond.*] **169**, 539–40 (*March* 29, 1952).

The presence of the layer referred to in the precedi abstract is consistent with the results of X-r intensity measurements made on samples of qua of different particle sizes. J. THEW

539.2

4639. On the structure of silicate glasses. YOKOTA. *J. Phys. Soc. Japan*, **6**, 489–94 (*Nov.–De* 1951).

The diagram of the molecular refraction Na_2O–SiO_2 glasses *v.* composition (Na_2O mol % = is found to be linear with breaks at $x = 0{\cdot}231$, $0{\cdot}33$ $0{\cdot}428$ and $0{\cdot}474$. Analysing this fact, it is conclud that at the latter three breaks the glass has loc arrangement of SiO_4 tetrahedra similar to that silicate crystals. The break at $x = 0{\cdot}231$ is brief discussed. By the introduction of Na_2O or oth oxides into SiO_2 glass, "solvation" takes place, ar also "solvation in refractivity"—decrease of refra tivity of SiO_4 tetrahedra—takes place. These effect due to the various metal ions, are summarized and th characteristics of ions in gases or aqueous solution are found to be preserved to some extent also in silica glasses.

539.215

4640. Study of imperfections of crystal structure i polycrystalline materials: low carbon alloy and silico ferrite. J. J. SLADE, JR AND S. WEISSMANN. *J. App Phys.*, **23**, 323–9 (*March*, 1952).

The technique of the new X-ray double spectr meter method [Abstr. 5913 (1951)] is applied to th study of angular misalignment of crystal structure i alloys. To obtain a better statistical evaluation o the X-ray intensity data the method is extended t include arrays of spots on the Debye–Scherrer line at high elevations. A complete mathematical dis cussion of the photometric transformation of th crystallite rocking curves is presented. The specimen investigated include a low C alloy annealed at 850° and 3 Si ferrite samples annealed at 980°, 1100° an 1200°C. The quantitative data obtained disclose significant dependence of crystal perfection o annealing temperature and demonstrate clearly tha the angular misalignment of the coherently reflectin regions within the grains decreases with annealing temperature provided this temperature is not excessive Valuable information regarding the influence of col rolling on the subsequent annealing process i obtained. Thus, the extent of partial recrystallizatio of the Si ferrite is deduced from the statistical data and the differential grain size between the surface layers and the interior of the specimen is revealed through the study of the diffraction effects wit radiation of different wavelengths. A mechanism o grain bending during plastic deformation is suggeste and a relationship between magnetic properties annealing temperature and crystal perfection of th Si ferrite is pointed out. A

539.217

541. Kinetics within the silver sulphate lattice. . JOHANSSON AND R. LINDNER. *Acta Chem. Scand.*, 782–8 (1950).

The self-diffusion of Ag in Ag_2SO_4 was followed at 50–650° by a radioactive tracer technique. The iffusion const., D, of Ag is given, below the transition oint at ~ 430°, by $D = (6{\cdot}7\times10^{-5})e^{-13,400/RT}$, and bove 430° by $D = 2{\cdot}5e^{-26,500/RT}$. Comparison with easured vals. of the electrical conductivity and the ansport no. of Ag^+ in Ag_2SO_4 indicate that the nductivity and diffusion in Ag_2SO_4 are due entirely the mobility of the Ag^+ ion. Direct measurement the diffusion const. of SO_4^{--} in Ag_2SO_4 at 180° dicates that its mobility is very low.

BRITISH ABSTRACTS

539.217

542. On the diffusion of Ag and Br ions in solid gBr. A. MURIN AND YU. TAUSH. *Dokl. Akad. auk SSSR*, **80**, 579–81 (*No.* 4, 1951) *In Russian.*

Measured by Tubandt's method, the self-diffusion oeffs. of Ag and Br in AgBr at 300°C, using as acers radioactive Ag and Br, were respectively $\cdot02\times10^{-7}$ and $2{\cdot}9\times10^{-11}$ cm²/sec, the former figure eing in satisfactory accord with the calculated value. he difference in the order of the diffusion rates is iscussed in terms of the theory of lattice vacancies.

F. QUELON

539.217

543. The permeability of ordinary paper under the fluence of liquid lipoids or their vapours. H. DEVAUX. .R. *Acad. Sci.* [*Paris*] **234**, 685–9 (*Feb.* 11, 1952) *In rench.*

Describes experiments, carried out 48 years ago, on riting paper. When this paper is treated by liquid ily substances or by their vapours it can be penetrated y water. Solid or semi-solid substances (e.g. waxes) o not have this effect. Photographs are reproduced hich show that the oils can produce two apparently ontradictory effects. If a sample of paper is placed a water and exposed momentarily (under a watch ass) to benzene vapour, the paper becomes wetted y water. On drying, the paper does not lose this roperty and it can be repeatedly dried and wetted. owever, if it is exposed to benzene vapour a second me while dry it loses the property of being wetted and is is also a permanent effect. An example is shown f a paper sample given the above treatments in 1904 nd it possesses the same properties after having been etted and dried many times over the intervening eriod. It is suggested that the effect is due to some splacement or reorientation of the molecules in the aper [see also Abstr. 2154 (1952)]. J. IBALL

539.217

544. Volume change in diffusion bodies during ffusion in mixed metal crystals. W. SEITH AND . KOTTMANN. Note in *Naturwissenschaften*, **39**,)–1 (*No.* 2, 1952) *In German.*

Presents results of experiments conducted with latively large-size crystals (3–15 mm) which were eviously subjected to prolonged annealing for the urpose of securing constant dimensions. The ystals were welded together in an A atmosphere and were then tightly embedded in powdered Al_2O_3 or C. The following metal pairs were examined: Au–Ag, Ag–Pd, Ni–Au, Cu–Ni and Ni–Co, the specimens being welded thus, A–B–A. It was found that both the total length of specimens and the diameter of the diffusion zones changed during diffusion. A lengthening of specimens indicates that new lattice planes are formed in the direction of the diffusion at the expense of holes formed in the diffusion zone. On the other hand, the shortening (in the case of Ag–Pd–Ag) indicates that some lattices have disappeared, and their material is found in the swelling around the diffusion zone. F. LACHMAN

539.217

4645. Introduction of partial diffusion coefficients for explaining the diffusion in metals. W. SEITH, T. HEUMANN AND A. KOTTMANN. Note in *Naturwissenschaften*, **39**, 41 (*No.* 2, 1952) *In German.*

An experiment on the "rod-shift" during diffusion gave the average value of $1{\cdot}85\times10^{-3}$ cm, while the calculated value is $1{\cdot}55\times10^{-3}$ cm. F. LACHMAN

539.217

4646. Diffusion in grain boundaries. M. H. DAWSON. Letter in *J. Appl. Phys.*, **23**, 373 (*March*, 1952).

It is suggested that the work of Achter and Smoluchowski [Abstr. 9012 (1951)] on the grain boundary diffusion of Ag in Cu may really only be a study of grain boundary precipitation as a function of solute supersaturation and of orientation difference at grain boundaries. A. D. LE CLAIRE

539.217

4647. Diffusion in grain boundaries. M. R. ACHTER AND R. SMOLUCHOWSKI. Letter in *J. Appl. Phys.*, **23**, 373–4 (*March*, 1952).

Five aspects of the authors' work are emphasized which refute the suggestion of the previous abstract.

A. D. LE CLAIRE

539.217

4648. Diffusion of indium into gallium near the melting point. R. E. ECKERT AND H. G. DRICKAMER. Letter in *J. Chem. Phys.*, **20**, 532 (*March*, 1952).

The coefficient of diffusion of indium into gallium was measured as a function of temperature. A rapid rise was observed just below the melting point of gallium. Two explanations are suggested. Empirical constants in the relation between diffusion coefficient and temperature are found, but they are stated to be not very accurate because of experimental difficulties.

A. J. TAYLOR

539.217.5

4649. A method for determining the concentration dependence of diffusion coefficient. H. FUJITA AND A. KISHIMOTO. *J. Phys. Soc. Japan*, **6**, 408–9 (*Sept.–Oct.*, 1951).

A procedure, somewhat simpler than that of Crank [Abstr. 6804 (1949)] or of Prager [Abstr. 8244 (1951)], is outlined using Fujita's method [*Mem. Coll. Agric. Kyoto Univ., No.* 59, 31 (1951)] for solving approximately one-dimensional diffusion equations involving diffusion constants with arbitrary concentration dependence. Agreement with Prager's results is obtained for values of $K(Cf)$ and $D(Cf)$. R. H. DAVIES

539.24 : 539.373

4650. On sub-boundary structure of aluminium. H. Iwamura and N. Shiota. *J. Phys. Soc. Japan*, **6**, 227–31 (*July–Aug.*, 1951).

Evidence is obtained to show that the sub-boundary structure of Al single crystals, as revealed by etch pits, varies considerably with their H_2 content. Assuming each dislocation to be the origin of an etch pit the disorientation between neighbouring sub-grains is calculated from the separation of etch pits along a sub-boundary. With increase in H_2 content this disorientation decreases and although the dimensions of the sub-grains at the same time increases, the strength of the crystal also increases. This is thought due to the anchoring effect on the dislocations of the H_2 atoms. A. D. LE CLAIRE

539.26

4651. The structure of an α/β brass. R. J. Davis, R. Pearce and W. Hume-Rothery. *Acta Cryst.*, **5**, 36–8 (*Jan.*, 1952).

In the annealed state ordinary etching methods reveal small angular crystals of the α phase embedded in large crystals of β. Careful electrolytic polishing and etching show that the large β crystals are in reality colonies of much smaller grains. This is confirmed by X-ray methods which show that the misorientation of the subgrains in any one colony is of the order of a few degrees and diminishes with the time of annealing. The angles on the α crystals occur at the boundaries of the β subgrains. The β substructure is also present in the alloy when extruded hot and finished by cold working. The effect of annealing on the form of the α and β crystals is described, and the reasons for the formation of the β substructure are discussed. A.

539.26

4652. The structure of alloys of lead and thallium. Y.-C. Tang and L. Pauling. *Acta Cryst.*, **5**, 39–44 (*Jan.*, 1952).

The structure is based upon cubic closest packing from 0 to about 87·5 atomic percent Tl. The variation of the lattice constant with composition gives strong indication that ordered structures $PbTl_3$ and $PbTl_7$ exist. In the intermediate ranges, solid solutions of the types $Pb(Pb, Tl)_3$ and $Pb(Pb, Tl)Tl_6$ exist. Interpretation of interatomic distances indicates that Tl atoms present in low concentration in Pb assume the same valence as Pb, about 2·14, and that the valence of Tl increases with increase in the mole fraction of Tl present, having the same value, about 2·50, in $PbTl_3$ and $PbTl_7$ as in pure Tl. A theory of the structure of the alloys is presented which explains the observed phase diagram, and which in particular accounts for the existence of a maximum melting point at about 63 atomic percent Tl. A.

539.26

4653. Technique of using X-rays for studying coke formation. A.-A. Peytavy and J. Lahouste. *C.R. Acad. Sci.* [*Paris*] **234**, 934–5 (*Feb.* 25, 1952) *In French.*

An X-ray beam is passed through a model coke-furnace and the processes are viewed on a fluorescent screen. Powdered baryta is added to the coal as a contrast medium. Radiography or ciné-radiography can replace the screen. It is possible to measure the speed of displacement of the layers in the furnace, and to differentiate between various types of coa[l] A schematic diagram is given. D. V. MAB[Y]

539.[2]

4654. A simplified scanner for X-ray diffractio[n] F. A. Underwood. *J. Sci. Instrum.*, **29**, 128-[9] (*April*, 1952).

A compact, simply constructed scanner for X-ra[y] diffraction, which is employed when it is desired [to] investigate the texture of specimens having lar[ge] grains, is described. It produces diffraction photo[-] graphs having arcs instead of the discrete spo[ts] normally obtained from such material, so that th[e] maxima on the Debye–Scherrer rings may be observe[d] Diffraction patterns for an annealed Al sheet specime[n] before and after scanning are reproduced.

539.26 : 539.53[1]

4655. Interpretation of the abnormal scattering o[f] X-rays by alloys structurally hardened. A. Guinier. *Acta Cryst.*, **5**, 121–30 (*Jan.*, 1952) *In French.*

Experimental results on diffuse scattering of X-ray[s] by age-hardening alloys are considered in terms o[f] the hypothesis of the segregation of atoms int[o] "zones" retaining the structure of the matrix an[d] also in terms of the precipitation of small inclusion[s] which grow progressively. Neither hypothesi[s] adequately explains the observations. It is concluded that the zones of segregation have an irregula[r] structure departing progressively from that of th[e] matrix and tending towards a crystalline structur[e] different from that of the first precipitate. At highe[r] temperatures the zones are unstable and true pre[-] cipitation occurs by germination and growth. Thu[s] the process of precipitation comprises two stages. A[.]

539.2[2]

4656. On the occurrence of streaks during electron[-] microscopic observation of very thin crystals. R[.] Bernard and E. Pernoux. *Optik*, **9**, 1–2 (*No.* 1[1] 1952) *In German.*

Three types of streak are observed: broad and diffuse; "fish-bone" shaped; and sharp and symmetrical. They arise from interference, and the first two are probably chemical in origin. All three systems are observed in MoO_3. J. THEWLIS

539.27

4657. On the question of object stresses in the electron microscope. O. Rang. *Optik*, **9**, 19–32 (*No.* 1, 1952) *In German.*

Discusses the effect of the type of fluorescent screen used in an electron microscope on the thermal loading of the specimen. With some types of screen the necessary electron current is so high that the specimen may be seriously affected; but the heating may be cut down appreciably by the use of thin fine-grained screens. These are capable of giving sharper images than the thick coarse-grained screens in common use, require less current, and may, moreover, be observed through a microscope. J. THEWLIS

539.27

4658. Tests on dust separators with the Siegbahn-Schönader electron microscope. E. de Haas. *Ark. Fys.*, **4**, 415–21 (*Paper* 26, 1952).

It is difficult to determine the efficiency of an electrostatic dust separator because it is usually used to remove sub-microscopic dust. Preliminary results

ce given to show that the use of an electron micro-cope is a possible solution. A method of sampling described using an auxiliary miniature electrostatic lter which enables the dust in a known volume of as to be examined. J. M. HOUGH

539.27

659. Structure of oxide replicas for electron icroscopy. S. YAMAGUCHI. *J. Appl. Phys.*, **23**, 45–7 (*April*, 1952).

The structure of oxide films, which could be used s replicas for electron microscopy, was investigated ere. In order to obtain a replica of the metal rface using the oxide film formed on it and isolated rom it, the oxide crystals composing the film must e oriented relative to the orientation of the substrate ace, The oxide crystals formed on metal, whose tom distances coincided with those of the substrate rystal, could compose a replicating film of the ecimen surface. This oxide film did not curl nor xpand upon removal from the substrate. A.

LASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.32

660. Elastic constants of beta-brass single crystals. . A. ARTMAN AND D. O. THOMPSON. *J. Appl. Phys.*, 3, 470–4 (*April*, 1952).

Measurements of Young's modulus and the rigidity odulus for a set of beta-brass single crystals of 5 atomic percent Cu and for single crystals of beta-rass near the Zn-rich phase boundary reveal a ependence of the elastic constants upon composition. omparison is made with previous results, whereby is found that the moduli of β-brass for different ompositions may be obtained by the use of a linear nterpolation in terms of the atomic ratio of Cu to n. Derived quantities are generally related in this anner also. The value of Σ_{111} (Poisson's ratio) is hown to be a positive quantity, in contrast to that erivable from previous results. Results of bending-orsion measurements are presented. The agreement etween measured values and those calculated from he principal elastic constants provides assurance for he consistency of the measurements. A.

539.32

661. The elastic constants of nickel. J. R. EIGHBOURS, F. W. BRATTEN AND C. S. SMITH. *. Appl. Phys.*, **23**, 389–93 (*April*, 1952).

The elastic constants of Ni have been determined y the pulsed ultrasonic method. Wave velocity easurements on 4 Ni single crystals of general rientation which were magnetically saturated were ombined by the approximation method leading to alues of the elastic constants $C_{11} = 2{\cdot}53$, $C_{12} = 1{\cdot}52$, $_{44} = 1{\cdot}24$, all in units of 10^{12} dyne cm^{-2}. A.

539.32 : 537.228.1

662. The elastic constants of piezoelectric crystals. . F. S. HEARMON. *Brit. J. Appl. Phys.*, **3**, 120–3 *April*, 1952),

The values available in the literature for the elastic onstants of the piezoelectric crystals Rochelle salt, otassium dihydrogen phosphate, ammonium dihydrogen phosphate, quartz, sodium chlorate and sodium bromate are assembled. The averages and standard deviations of the estimates are calculated, and the variability of the results discussed. The direct extension and lateral contraction stiffnesses of Rochelle salt show great variability which, however, is much reduced when the elastic constants are expressed as compliances. Little, if any, evidence is found of similar behaviour in the other materials. For comparison with the results on piezoelectric crystals, the available determinations on the non-piezoelectric crystals sodium chloride, lithium fluoride and pyrites are also summarized. It is concluded that elastic constants of crystals are seldom known to better than 1%, and in many cases the uncertainty is considerably larger. This variability is probably due to inherent variability in the materials rather than to experimental error or to differences caused by the use of different experimental methods. A.

539.32 : 539.67

4663. Temperature dependence of Young's modulus and internal friction of single crystals of beta-brass. R. A. ARTMAN. *J. Appl. Phys.*, **23**, 475–82 (*April*, 1952).

The crystals used contained 55 atomic percent Cu. Internal friction has been measured at 21 and 42 kc/s at room temperature and as a function of temperature to slightly above the complete disappearance of order. The room temperature decrement is for all crystals of the order of 10^{-4} and mainly independent of amplitude of oscillation. The decrement as a function of temperature shows a "relaxation peak." Zener's theory for α-brass is found to apply and the source of the relaxation is preferential orientation of pair axes of solute atoms in adjacent cells. The heat of activation is about 20×10^3 calories per mole. The relaxation peak is shown to be characteristic of the disordered state. There seems to be no relaxation phenomenon present in the ordered state. The effect of precipitation of the α-phase on Young's modulus and the internal friction has been found negligible unless a large amount of precipitation occurs. A.

539.373

4664. Some observations on slip lines in iron. H. W. PAXTON, M. A. ADAMS AND T. B. MASSALSKI. Letter in *Phil. Mag.*, **43**, 257–8 (*Feb.*, 1952).

The form of the slip lines, and in particular their spacing, is sensitive to the state of preparation of the surface in much the same way as previously observed for many f.c.c. metals [see Abstr. 1244 (1952)]. 5 plates. A. D. LE CLAIRE

539.373 : 548.24

4665. Effect of surface films on the twinning of metal crystals. R. KING. Letter in *Nature* [*Lond.*] **169**, 543–4 (*March* 29, 1952).

It is found that the stress necessary to produce twinning in Cd crystals is increased, and the extent to which slip occurs before twinning modified, by the presence of an oxide layer. H. P. MYERS

539.374

4666. On the plastic deformation of zinc bicrystal. II. T. KAWADA. *J. Phys. Soc. Japan*, **6**, 485–8 (*Nov.–Dec.*, 1951).

For Pt I, see 3928 (1952). The stress-strain curves

and the change of appearance during elongation of Zn bicrystal specimens are discussed by taking account of the mutual interaction of neighbouring crystals, disregarding the mechanical properties of grain boundary. For the mutual interaction the following assumptions are made: As a first step each crystal composing bicrystal specimens deforms freely, but each crystal neither intrudes into, separates from nor glides on the other at the grain boundary. Thus the shape of the specimen should differ from that in the case of free deformation; it undergoes some correction so as to accord with the above-mentioned mutual interaction. For this correction of the shape some other work should be introduced in addition to the work for the free elongation of two crystals of the bicrystal specimen, and from this additional work the stress-strain curves are deduced. A.

539.374

4667. The Lüders deformation of mild steel. E. O. HALL. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **64,** 1085–6 (*Dec.*, 1951).

Due to rapid ageing of the steel immediately behind the Lüders front, during a test in the blue-brittle range (around 200°c), a specimen can be permanently bent by straining in tension. J. G. OLDROYD

539.374

4668. A note on estimating yield-point loads in a plastic-rigid body. R. HILL. *Phil. Mag.*, **43,** 353–5 (*March*, 1952).

Bounds are obtained for the error committed when any approximate theory of plasticity is used to estimate yield-point loads. It is shown, for example, that, if the Mises yield function and potential are used to approximate the Taylor–Quinney data for copper, the error is less than 1% for a wide variety of loading programmes. A.

539.374

4669. Plasticity of wool. F. W. DRY, R. W. BURLEY AND J. B. SPEAKMAN. Letter in *Nature* [*Lond.*] **169,** 371–2 (*March* 1, 1952).

539.374

4670. Conditions for the derivation of the stress deviator tensor. O. L. ANDERSON. *Amer. J. Phys.*, **20,** 236–42 (*April*, 1952).

The decomposition of the stress tensor into the spherical stress tensor and the stress deviator found in theories of plasticity is shown to depend upon the postulate that the stress tensor is the tensor sum of two physically independent stress constituents. The decomposition is derived by two different methods, the first method based on energy arguments, and the second method based on cause and effect arguments. A.

539.374 : 536.7

4671. Thermodynamic criterion of the resistance to plastic deformation of solid solutions of metals saturated to the limit. K. A. OSIPOV AND B. P. STOYUKHIN. *Dokl. Akad. Nauk SSSR*, **80,** 627–30 (*No.* 4, 1951) *In Russian.*

539.374 : 539.89

4672. Deformation and fracturing of thick-walled steel cylinders under explosive attack. J. PEARSON AND J. S. RINEHART. *J. Appl. Phys.*, **23,** 434–41 (*April*, 1952).

Tests have been conducted on annealed heavy-walled cylinders of low carbon (1020) steel internally loaded by explosive charges. The purpose of these tests was to obtain basic information on the manner and type of fracturing and plastic flow obtained by extremely high pressures acting for short durations. It was observed that all of the cylinders tended to fracture in long fragments in the same basic pattern but with variations because of wall thickness and manner of loading. Experimental results indicate that the radial cleavage type of fracture is initiated within the cylinder wall and propagated to the surface while the shear type fracture associated with the inner portion of the cylinder wall appears as an independent energy relieving process. Microstructural analysis of the cylinder fragments shows a definite relationship between the type of fracture and the amount of distortion of the grain boundary. Considerable shock twinning is present in the cylinder fragments, and the grain structure near the inner surface shows severe distortion and flow. Strain measurements indicate that considerable plastic strain occurs during the explosive loading and cleavage fractures were always observed to occur in association with considerable plastic deformation. A.

539.38 : 539.2

4673. X-ray and mechanical measurements of deformation in quenched steel. F. BOLLENRATH AND V. HAUK. Note in *Naturwissenschaften*, **39,** 39–40 (*No.* 2, 1952) *In German.*

Stretched, compressed and bent bars were used as specimens. The X-ray measurements give lower values than the mechanical measurements: this may be due to strain relief caused by graphite plates between the metal crystals. A. R. STOKES

539.4.011.25

4674. The moving Griffiths crack. C. J. TRANTER. Letter in *Phil. Mag.*, **43,** 125 (*Jan.*, 1952).

Reference to a simpler solution of the dual integral equations given by Yoffe [Abstr. 8274 (1951)]. J. E. CAFFYN

539.4.011.25

4675. On the influence of length in the phenomenon of semi-brittle fracture. H. DE LEIRIS. *C.R. Acad. Sci.* [*Paris*] **234,** 1125–6 (*March* 10, 1952) *In French.*

Increasing the length of a notched tensile test-piece of mild steel is shown experimentally to favour premature semi-brittle fracture, in agreement with a theoretical prediction. J. G. OLDROYD

539.4.014.13

4676. Theory of stresses in gloss butt seals. N. L. SVENSSON; M. ZAID; H. RAWSON. Letters in *Brit. J. Appl. Phys.*, **3,** 30–2 (*Jan.*, 1952).

These letters criticize and extend the results of Rawson [Abstr. 7325 (1951)] by including the (small) effects of bending moments in glass–metal seals. Rawson agrees that his paper contains some printing errors but concludes that experimental results demonstrate the essential correctness of his theory for three component seals. A. H. W. BECK

539.4.016

4677. The nature of work-hardening. J. S. KOEHLER. *Phys. Rev.*, **86,** 52–9 (*April* 1, 1952).

Two kinds of work-hardening are discussed

nteraction-hardening and source-hardening. Inter-ction-hardening arises because a large stress must e applied to move a dislocation through a material hich already contains a large number of dislocations. his paper is mainly concerned with source-hardening hich occurs because the sources of easy glide become nactive. Additional glide occurs by the use of ources which act at a higher stress level. Source-ardening is the most important kind of hardening at mall strains since then the dislocation density is mall. The experimental stress strain curves obtained y Rosi and Mathewson on pure aluminum crystals an be calculated theoretically as follows: At very ow temperatures a distribution of "free lengths" of islocations is assumed. The Frank–Read mechanism or the production of dislocation is used. It is also ssumed in accordance with electron microscope data hat generation ceases after about 500 dislocation oops have been produced. Source-hardening there-ore occurs as the sources of greatest "free length" re gradually used. At finite temperatures the follow-ng modifications are introduced: The total stress is he sum of the applied stress and the stress resulting rom thermal fluctuations. In addition, Brown's lectron microscope data indicates that a given ource produces much more glide at high temperature han at low temperature. The present theory does ot predict an equation of state and does check Rosi nd Matthewson's data on this topic. Suggestions re made to explain the reason for the increased glide er source with increased temperature and to under-tand the way in which a source becomes inactive as a result of vacancy production. It is shown that the amella structure found in the electron microscope ictures can be related to the mechanical properties of the metal single crystals. A.

539.4.016 : 538.632

4678. Influence of cold-work on the Hall effect of a metal. B. WIENER AND G. GROETZINGER. *J. Appl. Phys.*, **23**, 441–4 (*April*, 1952).

Cold-work in Cu to the extent of 75% reduction in the cross-sectional area resulted in an increase in the Hall constant of $0{\cdot}01 \pm 0{\cdot}002$ times the Hall constant for annealed Cu. The value obtained for the Hall constant for annealed Cu was minus $5{\cdot}33 \times 10^{-13}$ volt-cm/ampere-gauss. A.

539.434

4679. On the relation between creep and vibrational loss of polymethylmetacrylate. E. FUKADA. *J. Phys. Soc. Japan*, **6**, 254–6 (*July–Aug.*, 1951).

From the creep formula, shear strain $= a + b\sigma \log_e(\theta + t)$ where t is time, a, b and θ constants, and σ stress, the variation of Young's modulus and damping with frequency may be calculated by Gross's method [Abstr. 1657 (1947)]. Such calculated results are in good agreement with experiment. The variation of loss with strain amplitude for a constant a.f. is also given. Results are briefly discussed in terms of the conventional viscoelastic model. A. J. KENNEDY

539.533 : 535.417

4680. Interferometric studies of hardness test indentations: investigations on tungsten carbide, steel, Duraluminium and tin. S. TOLANSKY AND D. G. NICKOLS. *Phil. Mag.*, **43**, 410–21 (*April*, 1952).

Studies are made on the surface distortions which occur on metal surfaces which have received hardness test indentations from both diamond pyramid and diamond cone indenters. The surface contours are evaluated by multiple-beam interference methods. Experiments are reported for indentations over a wide range of hardness, the surfaces studied being those of sintered tungsten carbide, nickel-steel, Duraluminium and tin. The distortions found in polycrystalline masses resemble one another but reveal secondary differences. On single crystallites of tin unsymmetrical patterns are found, with piling-up in two directions and sinking-in in directions at right angles to these. The effects are determined by the directions of the crystal axes. The concavity and convexity of the sides of the pyramid indentations are discussed in relation to piling-up and sinking-in, and the influence of recovery is indicated. A.

539.62

4681. Experimental study of sliding friction. C. A. MANEY. *Amer. J. Phys.*, **20**, 203–10 (*April*, 1952).

Reports an independent experimental study based on nonaccelerated motion involving sliding friction at speeds from 0·25 to 20 cm/sec. The experimental set-up consists of a weighted block resting upon a horizontal surface, subjected to the pull of various weights suspended over a pulley and attached to the block by means of a cord. For all materials tested, including wood, leather, glass and various metals, it is found that (1) the coefficient of sliding friction varies as the logarithm of the speed of the moving surface, increasing directly as the logarithm of the speed increases, (2) in the case of wood surfaces in contact, the coefficient of sliding friction decreases as the normal force increases, (3) in the case of both wood and leather surfaces in contact with other surfaces, the coefficient decreases with repeated performance, and (4) in the case of metal surfaces in contact, the coefficient of friction increases with repeated performance, unless the product of the abrasive action of friction is removed for each performance. The removal of the loose metallic particles causes a decreased coefficient of friction. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.11

4682. Relations between activation energy, rate of reaction, bond dissociation energy, and heats of formation, atomization, and reaction for the substituted methanes. H. J. BERNSTEIN. Letter in *J. Chem. Phys.*, **20**, 524 (*March*, 1952).

Includes the following 3 relations, the detailed derivations of which are to be presented in forthcoming publications: (1) between the activation

energy, bond dissociation energy, heat of formation, heat of atomization, and heat of reaction; (2) between activation energy and rate of reaction in 3-atom reactions, and (3) between the equilibrium constants for 2 types of 3-atom reactions of the substituted methanes. F. LACHMAN

541.115

4683. The pyrolysis of *n*-propyl-benzene and the heat of formation of ethyl radical. C. H. LEIGH AND M. SZWARC. *J. Chem. Phys.*, **20**, 403–6 (*March*, 1952).

The investigation of the pyrolysis of *n*-propyl-benzene by the "toluene carrier" technique revealed that this compound decomposes initially into benzyl and ethyl radicals: $C_6H_5 . CH_2 . C_2H_5 \rightarrow C_6H_5 . CH_2 . + C_2H_5$. Ethyl radicals decompose rapidly into ethylene and hydrogen atoms. The hydrogen atoms reacting with toluene produce H_2 or CH_4. The rate of the initial dissociation process can be measured by the rate of formation of C_2 hydrocarbons. It was shown that the decomposition is a homogeneous, first-order gas reaction. The activation energy was estimated at 57·5 kcal/mole, the frequency factor at 3×10^{12} sec^{-1}. It appears that the activation energy is equal to $D(C_6H_5 . CH_2 - C_2H_5)$. Since the heat of formation of benzyl radicals is known, the estimation of $D(C_6H_5 . CH_2 - C_2H_5)$ leads to the value for the heat of formation of ethyl radicals, i.e. $\Delta H_f(C_2H_5) \simeq$ 22 kcal/mole. The latter value makes it possible to evaluate various relevant bond dissociation energies, i.e. $D(C_2H_5 - H) \simeq 94 + 4$ kcal/mole. A.

541.115

4684. The pyrolysis of *n*-butyl-benzene and the heat of formation of *n*-propyl radical. C. H. LEIGH AND M. SZWARC. *J. Chem. Phys.*, **20**, 407–11 (*March*, 1952).

It has been shown that the pyrolysis of *n*-butyl-benzene results in its dissociating into benzyl and *n*-propyl radicals, $C_6H_5 . CH_2 . CH_2 . CH_2 . CH_3 \rightarrow C_6H_5 . CH_2 . + . CH_2 . CH_2 . CH_3$, (1) and the propyl radicals subsequently decompose to give ethylene and methyl radicals, $CH_3 . CH_2 . CH_2 . \rightarrow CH_3 . + C_2H_4$. By the use of the toluene-carrier technique, it has been possible to measure the rate of reaction (1) by measuring the rate of formation of ethylene. The activation energy of reaction (1) has been thus determined at 65 kcal/mole. The latter value has been identified with the $C_6H_5 . CH_2 - C_3H_7$ bond dissociation energy, i.e. $D(C_6H_5 . CH_2 - CH_2 . CH_2 . CH_3) =$ 65 kcal/mole. Since $D(C_6H_5 . CH_2 - C_3H_7) = \Delta H_f(C_6H_5 . CH_2) + \Delta H_f(n - C_3H_7) - \Delta H_f(n . C_6H_5 . C_4H_9)$, and $\Delta H_f(C_6H_5 . CH_2) = 37·5$ kcal/mole, one may compute the unknown value for $\Delta H_f(n - C_3H_7)$, namely, $\Delta H_f(CH_3 . CH_2 . CH_2 .) \simeq 24$ kcal/mole. With $\Delta H_f(n - C_3H_7)$ the dissociation energy of the primary C – H bond in propane was found to be $D(C_3H_7 - H) = \Delta H_f(n - C_3H_7) + \Delta H_f(H) - \Delta H_f(C_3H_8) \simeq 100$ kcal/mole. A.

541.123.5

4685. The kinetics of the exchange of tritium between hypophosphorous acid and water. W. A. JENKINS AND D. M. YOST. Letter in *J. Chem. Phys.*, **20**, 538–9 (*March*, 1952).

541.121

4686. The reaction of nitrous acid with hydroxylamine. A. BOTHNER-BY AND L. FRIEDMAN. *J. Chem. Phys.*, **20**, 459–62 (*March*, 1952).

Approximately equal quantities of $N^{14}N^{15}O^{16}$ and $N^{15}N^{14}O^{16}$ are produced by reaction of hydroxylamine hydrochloride and N^{15}-enriched sodium nitrite in solution in O^{18}-enriched water. The same reaction when carried out in a solution brought to a pH of with gaseous HCl produces an excess of $N^{14}N^{15}O^{16}$. In both experiments the concentration of $N^{15}N^{15}O^{1}$ was accounted for on the basis of the reaction of nitrous acid with hydroxylamine to yield nitrous oxide molecules containing one nitrogen atom from each source. O^{18} exchange occurred to a greater extent in acid medium and the double tagged N_2O so produced was mainly $N^{14}N^{15}O^{18}$ rather than a mixture of the isomers $N^{14}N^{15}O^{18} + N^{15}N^{14}O^{18}$. These observations lead to the following conclusions concerning the reaction mechanisms. In neutral solution most of the nitrous oxide produced is formed by dehydration of a symmetrical intermediate, probably hyponitrous acid. In acid medium a competitive dehydration of an unsymmetrical intermediate plays an important role. Mechanisms involving nitroxyl as an intermediate are untenable. Oxygen exchange is acid catalysed and occurs exclusively with nitrous acid or with an unsymmetrical intermediate formed in the course of this reaction. Oxygen atoms from either nitrous acid or hydroxylamine appear in the product nitrous oxide. A.

541.124 : 534.39

4687. The chemical effects produced by ultrasonic waves. O. LINDSTRÖM AND O. LAMM. *J. Phys. Coll. Chem.*, **55**, 1139–44 (*Oct.*, 1951).

An investigation of the kinetics of the polymerization of acrylonitrile in aqueous solutions by ultrasonic waves confirms the hypothesis that the chemical effects of such waves on water and aqueous solutions result from the production of free H and OH radicals during cavitation. Increased oxidation effects in the presence of oxygen are attributed to the effect of molecular oxygen on the secondary reactions of such radicals. C. B. ALLSOPP

541.124.2 : 541.64

4688. On the kinetics of chain polymerization and the molecular weight distribution of polymer. I. First order initiation at the steady state. D. TABUCHI. *Mem. Res. Inst. Acoust. Sci. Osaka*, **2**, 61–90 (*March*, 1951).

In order to compare results with those of the statistical methods of Schulz (1935, 1939) and Inoue (1948), relations are derived based on chemical kinetics to describe polymerization reactions. Three cases are considered: termination of the reaction by monomers, spontaneous termination, and termination by recombination of active molecules. It is assumed that the reaction is of the first order for the monomers. For each of these cases relations are found for the numbers of monomer and polymer molecules present, as well as for the weight fraction of terminated and active molecules, for the distribution function of the polymers and the mean degrees (weight and number average) of polymerization. For the first case it is

hown that Schulz's results are equivalent to those btained here, if the number of active molecules is nall. If this is not so, Schulz's equations are stated o be inadequate. For the third case no good agree- ient is obtained with the results of Schulz, but those f Inoue agree well, when the number of active olymer molecules present is small. A. J. TAYLOR

541.126

589. Second limit of hydrogen-oxygen mixtures by ie withdrawal method. R. R. BALDWIN AND R. M. RECIOUS. Letter in *Nature* [*Lond.*] **169**, 290–1 (*Feb.* 5, 1952).

Describes 2 observed phenomena: (1) complete limination of the second explosion limit for a H_2–$2O_2$ mixture in clean Pyrex vessels at *c.* 480°C when ie evacuation rate was reduced below the value of . 1 mm/sec, and (2) a reduction of the second limit for $2H_2$–O_2–$4N_2$ mixture with a lower pumping speed, nd suggests 2 possible mechanisms to account for the hibition. F. LACHMAN

541.127

690. Acceleration mechanism of certain chemical eactions under the action of an electric field. J. IMA-DE-FARIA. *C.R. Acad. Sci.* [*Paris*] **234**, 948–50 *Feb.* 25, 1952) *In French.*

A mechanism is proposed for chemical reaction cceleration under the influence of an electric field, hich is based on an experimental study of the nteraction of $Pb(NO_3)_2$ and NaI. The qualitative esults afford a sensitivity 10 times as great as that btained under normal conditions [Abstr. 9766 1951)]. H. H. HODGSON

ELECTROCHEMISTRY 541.13

541.132

691. First dissociation constant of phosphoric acid rom 0° to 60°C; limitations of the electromotive force ethod for moderately strong acids. R. G. BATES. *Res. Nat. Bur. Stand.* [*Wash.*] **47**, 127–34 (*Sept.*, 951).

An accurate determination by the electromotive- orce method of the dissociation constant of an acid s strong as the first acidic group of phosphoric acid equires that the hydrogen-ion concentration be stablished with greater accuracy than is usually ttainable. The uncertain quantity is the activity oefficient of hydrochloric acid in the particular ixture under study. It is shown that the calculation f this coefficient by the Debye–Hückel equation, hich affords an adequate estimate of the small ydrogen-ion correction in buffer solutions composed f weak acids, fails to yield the desired accuracy for ixtures in which the acid is dissociated to an appre- iable extent. In order to determine the common garithm of the first dissociation constant of phos- horic acid with an accuracy believed to be $\pm 0{\cdot}005$ nit, the hydrogen-ion concentration of some of the uffer mixtures studied was kept at low levels by use f a large excess of potassium dihydrogen phosphate. ther solutions contained formic acid instead of ydrochloric acid, thereby lowering the hydrogen-ion oncentration still further. In addition, particular attention was given to a choice of reasonable values for the activity coefficient used to estimate the hydrogen-ion correction. A.

541.135

4692. Anion affinity and polarising power of cations. L. H. AHRENS. Letter in *Nature* [*Lond.*] **169**, 463 (*March* 15, 1952).

The ionization potential of cations might be used as a relative measure of their power to attract and polarize anions. Some examples are given.

A. J. TAYLOR

541.135.5

4693. Solid films on electropolishing anodes. T. P. HOAR AND T. W. FARTHING. Letter in *Nature* [*Lond.*] **169**, 324–5 (*Feb.* 23, 1952).

The authors conclude, from experiments described, that a continuously forming and dissolving compact solid film, absent during etching, is present on the surface of copper and α-brass electro polishing anodes used in a phosphoric acid bath. H. P. MYERS

541.135.5 : 532.5

4694. Hydrodynamics of cathode films. G. H. KEULEGAN. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 156–69 (*Sept.*, 1951).

A hydrodynamical theory of the cathode diffusion layer based on the assumption of a uniform density reduction at the cathode surface is presented. By means of an approximate solution for the flow and the diffusion equations, the layer dimensions, the velocity distributions, and the densities are determined. Further derivations from the solutions directly applicable to results obtained by the freezing method are effected. The data of Brenner on copper and nickel baths are considered. Using the observed values of the density reductions at the cathode surface, the maximum width of the layer, the average densities for a given distance from the cathode, and the mobilities of the cations are determined and compared with the observations. The agreement between observed and computed values is regarded as fairly satisfactory. A.

541.138

4695. Cathodic reduction of cupric oxide. P. JOLIBOIS AND A. SANCELME. *C.R. Acad. Sci.* [*Paris*] **234**, 1007–10 (*March* 3, 1952) *In French.*

Previously calcined cupric oxide is electrolytically reduced at a platinum cathode to copper in $0{\cdot}5$ N H_2SO_4 with maximum Faraday efficiency, the grains being reduced without external modification. In $0{\cdot}1$ N H_2SO_4, the reduction is less efficient, and the copper is mixed with cuprous oxide. Green $Cu(OH)_2$ reduces badly, but 4 CuO . H_2O gives better results. Two new crystalline varieties of CuO and Cu_2O respectively have been isolated. H. H. HODGSON

541.138

4696. Reaction velocities and activation energies of some "instantaneous" complex ion reactions. J. BJERRUM AND K. G. POULSEN. Letter in *Nature* [*Lond.*] **169**, 463–4 (*March* 15, 1952).

Describes and gives some numerical results of experiments on "instantaneous" complex ion reactions carried out in CH_3OH solutions at −75°C and −100°C with various complex systems having strongly

coloured complexes ($Fe^{+++} + S_2O_3^{--}$; Ni^{++} + dimethylglyoxime, or pyridine, or ethylenediamine; $SCN^- + PdCl_4^{--}$, or $AuCl_4^-$, or $PtCl_6^{--}$, or Fe^{+++}; dithizone + Hg^{++}, Co^{++} or Ni^{++}).

F. LACHMAN

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

4697. The substitution reactions of bromine activated by neutron capture. I. The formation of bromine derivatives of toluene. G. GAVORET AND N. IVANOFF. *Bull. Soc. Chim. France*, **19**, 166–9 (*Jan.–Feb.*, 1952) *In French.*

The proportion of benzyl bromide obtained by reaction of toluene with Br^{82}(34 hr) is much greater than in the reaction with Br^{80}(18 min), whereas the ratio of *o*-, *p*-, *m*-isomers in the bromotoluene formed is approx. 4 : 2 : 1 in each case. Experimental details of the methods used for separation of the reaction products are given. G. I. W. LLEWELYN

541.15

4698. The hot atom chemistry of the propyl bromides; effect of phase and recoil energy on retentions. M. S. FOX AND W. F. LIBBY. *J. Chem. Phys.*, **20**, 487–97 (*March*, 1952).

The yields of the various organic radiobromides formed by neutron irradiation of liquid and solid iso and normal propyl bromides at various temperatures have been determined. Very careful purification of the propyl bromides has given good reproducibility and evidence that the main features of the hot atom chemistry of the propyl bromides have been discovered. The solidification at the melting point results in a threefold or larger increase in yield of certain products, presumably those formed by epithermal bromine atoms, and a smaller increase for the remainder of the products, such as the mother molecule, presumably formed by hot reactions. Isomerization of isopropyl to *n*-propyl appears to occur with high probability in epithermal reactions. The epithermal production of bromides of considerably higher boiling point than the mother molecule has been confirmed and the phenomenon discussed theoretically. Apparently the retentions in the solid phase depend on energy of the recoil bromine, 36-hr Br^{82} showing 93% retention in solid *n*-propyl *v* 80% for the 18-min and 4·4-hr Br^{80}'s. This is in contrast to the liquid retentions in which no difference has been observed. On this basis it is concluded that the average recoil energy of the 36-hr Br^{82} is less than those of the two Br^{80} isomers and that the latter two differ relatively little. The theoretical implications of the observed product distributions and the phase effect on these distributions and the sensitivity to recoil energy are discussed. A.

541.15

4699. The effect of iodine in the radiolysis of the hydrocarbons. C. C. SCHUBERT AND R. H. SCHULER. Letter in *J. Chem. Phys.*, **20**, 518–19 (*March*, 1952).

The production of H_2 and CH_4 by 120-keV X-radiation on samples of cyclohexane and 2, 2, 4, trimethylpentane containing different concentrations of I_2 has been investigated. With I_2 concentration in the range 0·0135–0·05M an approximately linear relation is found between gas production and I_2 concentration. G. I. W. LLEWELYN

541.15 : 615.84

4700. Possible biological significance of the action of ionizing radiations on nucleic acids. J. WEISS. Letter in *Nature* [*Lond.*] **169**, 460–1 (*March* 15, 1952).

It is suggested that the biological action of ionizing radiation on e.g. deoxyribonucleic acid mol. wt. $\sim 3 \times 10^6$ should give a "multiplication factor" of $\sim 10^4$ if the molecule is (biologically) deactivated by the destruction of one of its nucleotide units. The action of the "radiomimetic" nitrogen mustard compounds can be explained on a similar basis although the mode of their chemical activity differs from the radicals produced by ionizing radiations.

T. A. CHALMERS

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.18 : 535.34–32

4701. Absorption in the ultra-violet by colloidal gold solutions. B. SERAPHIN. *Ann. Phys.* [*Lpz.*] **10**, 1–19 (*No.* 1–2, 1952) *In German.*

It has been found that the absorption-intensity/particle-size relationship derived from measurements on gold sols in the range 2900–6000 Å is inverse to that calculated from Mie's theory. Satisfactory agreement with experiment has been obtained by introducing the supplementary absorption resulting from a quantum-mechanical theory by Möglich and Rompe, applied to this case. F. LACHMAN

541.18.041

4702. The acid decomposition of dilute sodium thiosulfate. E. M. ZAISER. Letter in *J. Chem. Phys.*, **20**, 538 (*March*, 1952).

Points out that Kerker's explanation [Abstr. 1284 (1952)] that the optical density at t_B (the induction period) is due, among other factors, to tetra- and pentathionates produced by the acid-thiosulphate reaction, ought to be further qualified, viz. that the latter factor is important only when the concentrations of the reactants are particularly high. F. LACHMAN

541.182.5 : 539.32

4703. Ultrasonic investigation of elastic constants of iron silicate gels. A. M. SRIVASTAVA. *J. Phys. Coll. Chem.*, **55**, 1446–55 (*Dec.*, 1951).

An ultrasonic pulse technique has been developed to evaluate the elastic constants of gelatinous substances. The method is based upon the total reflection of the incident waves at certain angles, from which the elasticities are determined. The accuracy is more than 1 part in 100. No prolonged preparation of the sample is needed; the pulsed energy does not produce any harmful effect on the gel structure. The elasticities of iron silicate gels were measured at different frequencies and temperatures. The effect of the time of setting from the moment of the formation of the gel has also been investigated at length. A structure of the gel is proposed on the basis of these data. According to the elastic processes, the gel

ust be an aggregate of randomly distributed groups atoms interwoven in a three-dimensional lattice ame. A.

541.182.6

704. Electron microscope investigation of the echanism of particle growth in V_2O_5 sols. A. V. ROMBERG, V. M. LUKYANOVICH, V. V. NEMTSOVA, . V. RADUSHKEVICH AND K. V. CHMUTOV. *Dokl. kad. Nauk SSSR*, **80**, 615–17 (*No.* 4, 1951) *In ussian.*

541.183

705. Reaction of a barium film with oxygen. I. . KOBAYASHI AND S. FURUYA. *J. Phys. Soc. Japan*, 238–43 (*July–Aug.*, 1951).

Details are given of experiments in which oxygen acts with a barium getter. Analysis of the results ows that the following processes operate; adsorption f O_2; dissociation $O_2 \rightarrow 2O$ on the surface; O + a→BaO; diffusion of adsorbed molecules along rain boundaries of the BaO. S. J. GREGG

541.183

706. The surface layer of liquid argon. T. INOUYE. *Phys. Soc. Japan*, **6**, 243–8 (*July–Aug.*, 1951).

The general method of Kirkwood [*J. Chem. Phys.*, 7, 988 (1949)] is applied to a model in which the rface zone has a finite thickness τ, i.e. has not shrunk a mathematical surface. Application to numerical ata gives $\tau = 3$ to 4 Å. S. J. GREGG

541.183

707. Thermodynamics of adsorption from solution. V. Temperature dependence of adsorption. F. E. HARTELL, T. L. THOMAS AND YING FU. *J. Phys. Coll. Chem.*, **55**, 1456–62 (*Dec.*, 1951).

For Pt III, see Abstr. 6811 (1950). The effect of emperature on the adsorption of butyl alcohol from queous solutions by graphite and blood char has een studied. At lower concentrations, adsorption ecreases with increasing temperature; at higher concentrations, the reverse is true. It has been concluded hat the temperature effect has two factors: (1) the normal" and (2) the solubility effects. At higher oncentrations the second factor predominates and verbalances the first factor. A method for the calulation of changes of standard free energy and heat ontent of the adsorbate in adsorption processes has een proposed and applied to the present systems. his method consists in obtaining the equilibrium onstant K from the limiting slope of the adsorption sotherms at zero concentration. The results so btained indicate that the absolute value of $\Delta H°$ is ot higher than that of $\Delta F°$, as in the case of adsorption f gases. A.

541.183

708. A note on some proposed equations of state or the expansion of rigid porous solids on the adsorption f gases and vapours. D. J. C. YATES. Letter in *roc. Phys. Soc.* [*Lond.*] *B*, **65**, 80–1 (*Jan.*, 1952).

It is pointed out that a better model for the processes aking place should be obtained by relating the xpansion constants on absorption to the bulk nodulus rather than to Young's modulus. An xpression is derived connecting these quantities nd the thermodynamic consequences are examined. Relations are deduced for the differential coefficients of the free surface energy in terms of experimentally measurable thermodynamic variables. F. E. HOARE

541.183

4709. Surface adsorption of small ions in solutions of surface active agents. C. M. JUDSON, A. A. LEREW, J. K. DIXON AND D. J. SALLEY. Letter in *J. Chem. Phys.*, **20**, 519–20 (*March*, 1952).

Experiments with di-n-octyl sodium sulphosuccinate (NaX) by radioactive tracer technique show that at low conc. (*c.* 10^{-4}M) the species mainly adsorbed at the air-water interface are HX and not NaX. With solutions of NaX plus xM Na_2SO_4, the adsorption of SO_4^{--} reaches *c.* 250 times the adsorption of X when $x \simeq 0{\cdot}1$ M. S. J. GREGG

541.183 : 531.724

4710. Calculation of surface areas from room temperature adsorption isotherms. N. BERKOWITZ AND H. G. SCHEIN. Letter in *Nature* [*Lond.*] **169**, 373 (*March* 1, 1952).

By consideration of the results for adsorption and heat of wetting of methanol on lignites at 25°C it is suggested that the Brunauer–Emmett–Teller procedure for determination of surface area is unreliable (except at low temp.) in those cases where the slope of the linear portion of the adsorption isotherm increases with temp. S. J. GREGG

541.183 : 536.424

4711. Phase transitions in adsorbed films. L. MEYER AND E. LONG. *Phys. Rev.*, **85**, 1035–7 (*March* 15, 1952).

A thermodynamic treatment of first- and second-order transitions in adsorbed layers is given. The results are compared with the experimental evidence for the melting of argon and the transition He I — He II in adsorbed layers. A.

541.183.3

4712. The radioactive measurement of the adsorption of dissolved substances on liquid surfaces and an application to "impurities" in dodecyl sodium sulfate solutions. G. ANIANSSON. *J. Phys. Coll. Chem.*, **55**, 1286–99 (*Nov.*, 1951).

The use of soft β-emitters, α-emitters, and isotopes with radioactive recoil atoms for the measurement of the adsorption of dissolved substances at liquid surfaces is discussed. A method is described for measurements with S^{35}, C^{14} and Ca^{45}. Results of measurements of the surface adsorption of hexadecyl Na sulphate and Ca ions as "impurities" in dodecyl Na sulphate are given and discussed. A.

541.183.576

4713. Adsorption isotherms of mixed vapors of benzene and methanol on activated charcoal at 25°C. W. B. INNES, R. B. OLNEY AND H. H. ROWLEY. *J. Phys. Coll. Chem.*, **55**, 1324–34 (*Nov.*, 1951).

See also Abstr. 1106 (1948).

CHEMICAL STRUCTURE 541.2/.6

541.45

4714. Brønsted and Lewis acidity. W. F. LUDER. Letter in *J. Chem. Phys.*, **20**, 525 (*March*, 1952).

In answer to Ferreira [Abstr. 7358 (1951)] it is

pointed out and illustrated by some examples, that Lewis acidity is not solely determined by the partial positive charge of the H atom, and that it is identical with Brønsted acidity. A. J. TAYLOR

541.51 : 539.132

4715. Valence. C. A. COULSON. *London, Oxford University Press* (1952) 350 *pp.*

"Modern wave mechanics has revolutionized our description of the nature of a chemical bond. This book not only gives an account of this new description, but also develops the necessary wave-mechanical theory in a simple manner and from the beginning. Diatomic and polyatomic molecules are dealt with as well as aromatic systems. Other topics include stereochemistry, hyperconjugation hybridization, and the hydrogen bond. A notable feature is the parallel use of the molecular-orbital methods and the valence-bond resonance method. This book is suitable for honours students in chemistry as well as for research workers and school teachers."

541.57

4716. The stability of nonpolar covalent bonds. R. T. SANDERSON. Letter in *J. Chem. Phys.*, **20,** 535 (*March,* 1952).

The observation that in a group of non-polar covalent binary compounds of any particular element the thermal stability diminishes with increasing difference in radii of the combined atoms (e.g. in the sequence CH_4, PH_3, GeH_4, HI, H_2Te, SbH_3, BiH_3, PbH_4, HgH_2) is proposed as a general principle.

F. LACHMAN

541.64 : 532.71 : 533.15

4717. Some recent work on diffusion in high polymers. J. CRANK AND G. S. PARK. *Research* [*Lond.*] **4,** 515–20 (*Nov.*, 1951).

A review covering the last five or six years of the experimental and theoretical work on the diffusion of liquids and vapours in high polymer substances. Thirty references. J. IBALL

CHEMICAL PROCESSES 542.9

542.923 : 539.27

4718. Electron diffraction study of the [*in vacuo*] decomposition of magnesium chloride hydrate. R. LECUIR AND [MME] R. LECUIR. *C.R. Acad. Sci.* [*Paris*] **234,** 832–5 (*Feb.* 18, 1952) *In French.*

At room temperatures, the diffraction pattern of $MgCl_24H_2O$ was obtained. As the specimen temperature was raised diffraction patterns of MgOHCl and MgO were successively obtained, at about 100°C and 350°C respectively. The transition from $MgCl_24H_2O$ to MgOHCl involves an intermediate disordered state. See also Abstr. 3915 (1952). R. S. PEASE

542.93 : 545.8 : 539.27

4719. A study on corrosion-process of iron by means of electron diffraction. R. ABE. *J. Phys. Soc. Japan,* **6,** 345–50 (*Sept.–Oct.*, 1951).

CHEMICAL ANALYSIS 543/545

543.71

4720. A sensitive method for the detection of trace of water in oil. J. E. C. STRINGER. Letter in *Natur* [*Lond.*] **169,** 412 (*March* 8, 1952).

This new method depends on the fact that perfectl dry air standing over a "wet" oil takes up moistur from the oil until the partial relative humidity, at th prevailing room temperature, is equal to the volum concentration of the water in the oil. A humidiscop devised to determine this partial humidity is briefl described. It consists of a vertical metal tube divide into two chambers, the upper containing air an powerful dessicant and the lower the oil sample which are separated by a pipe-clay diaphragm an connected by an oil manometer. It is shown tha the relative humidity of the air above the wet oil is given by $p^2/(p_{sat}\times 13{\cdot}6\times 1/0{\cdot}871)^2$ where p is the vapour pressure of oil in mm Hg, 0·871 the sp gravity of the manometer oil and p_{sat} is the saturated water vapour pressure. Results for castor oil, olive oil and two light mineral oils are given. S. WEINTROUE

545.37

4721. Variations of the wave height with the rate of potential change in oscillographic polarography. P. DELAHAY AND G. PERKINS. *J. Phys. Coll. Chem.*, **55,** 1146–51 (*Oct.*, 1951).

The heights of a few irreversible cathodic waves have been determined by a single-sweep method and by a multi-sweep method of measurement. The heights measured by the former method are larger than those obtained by the latter. The difference in wave height is due to the decrease in concentration of reducible substance at the surface of the mercury drop. This decrease in concentration is caused by the incompleteness of the anodic process occurring during the quiescent period of the voltage wave. A.

545.7

4722. Modern methods of gas analysis. H. GUERIN. *Bull. Soc. Chim. France,* **19,** 24–33 (*Jan.–Feb.*, 1952) *In French.*

A résumé of existing methods. The principal physical methods dealt with are based on selective diffusion of the constituents of a mixture, fractional desorption and distillation at const. pressure, thermal, electrical conductivity and magnetic susceptibility measurements of mixtures, on measurements of the heat produced on absorbing gases in solvents (thermo-flux method), and on absorption and mass spectroscopy. J. GRANT

545.7

4723. A modified "thermal conductivity" gas analyser for measuring methane in air or carbon dioxide. F. W. PRITCHARD. *J. Sci. Instrum.*, **29,** 116–17 (*April,* 1952).

The use of convective instead of conductive heat transfer from the filament of a gas analyser of the "thermal conductivity" type enables the instrument, in some circumstances, to be made insensitive to a third gas component. The principle has been applied to the measurement of methane in N–CO_2–O mixtures. Examples of other possible applications are the

easurement of CO_2 in the presence of air–methane, r–water vapour or air–hydrogen mixtures. A.

545.82

724. Method of differential analysis in infrared ectrophotometry. G. DUYCKAERTS. *Bull. Soc. Roy. i. Liège*, **21**, 7–17 (*Jan.*, 1952) *In French.*

Increased accuracy in concentration measurements possible by measuring an unknown concentration gainst a standard solution (1) instead of against the lvent (2). With a Beckmann IR2 the limit is sually determined by the energy available; this is mited by the maximum slit width that may be used. leasurements on mixtures of xylenes near $\lambda = 13\ \mu$ ow a mean relative error of 0·7% by method (1) id about 2·7% by method (2). G. F. LOTHIAN

545.82

725. Technique for photographic emulsion calibration. Intensity factor tables. E. S. HODGE AND H. R. OLOB. *Appl. Spectroscopy*, **6**, 32, 34, 36 (*Feb.*, 1952).

If the transmittance of the neutral stepped filter sed in quantitative spectrochemical analysis is $T\%$, ne factors required for emulsion calibration are owers of $100/T$. The table lists values of $(100/T)^n$ ith T varying from 35 by steps of 0·5 to 82·5 and n king integral values from 1 to 10 when $T < 60$ and om 1 to 15 when $T > 59·5$. S. T. HENDERSON

545.824

726. Metallurgical applications of X-ray fluorescent nalysis. P. K. KOH AND B. CAUGHERTY. *J. Appl. hys.*, **23**, 427–33 (*April*, 1952).

Techniques are described for fluorescent analysis sing an X-ray Geiger counter goniometer. Conideration is given to the influence of potential varia-ions, specimen preparation and thickness of the iffracting crystal. The observed intensity of fluorescent radiation from a number of common commercially pure metallic elements was compared under a constant primary radiation that can be closely maintained in practice. Intensities of fluorescent spectra were measured on constituents of Fe–Ni, Fe–Cr and Fe–Ni–Cr alloys. Calibration curves correlating line intensity with weight percentage are included for binary Fe–Ni and Fe–Cr alloys. The thickness beyond which the fluorescent intensity becomes constant has been determined for pure Fe, Ni and Cr. Up to the above thickness for each element an empirical plot of fluorescent intensity against thickness of layer has been established. These empirical plots can be applied to measure the thickness of very thin coatings. Illustrations are given indicating the applications of the fluorescent analytical technique to the study of oxidation and diffusion processes in metallic systems. An Al holder is used for analysing small quantities of powder derived from chemical or electrolytic extraction of certain phases from alloys. Fluorescent analysis on the extracted phase supplements the diffraction data when a wide solid solubility exists. A.

545.824 : 548.73

4727. On quantitative phase analysis of fine-grained mixtures with X-rays. W. v. ENGELHARDT, H. FÜCHTBAUER AND H. GOLDSCHMIDT. Note in *Naturwissenschaften*, **39**, 82–3 (*No.* 4, 1952) *In German.*

The considerations of Alexander and Klug [Abstr. 760 (1949)] are applied in particular to mixtures of clay minerals, a Geiger-counter X-ray spectrometer being used. Determinations on artificial mixtures were found to be within a few % of the made-up compositions; e.g. a mixture of four minerals in proportions 18 : 44 : 28 : 10% was analysed to contain 17 : 50 : 29 : 9½%. A. J. C. WILSON

CRYSTALLOGRAPHY 548

548.0 : 535.327

4728. The relation between thermo-optic and piezo-optic phenomena in crystals. G. N. RAMACHANDRAN AND T. RADHAKRISHNAN. *Phil. Mag.*, **43**, 317–26 (*March*, 1952).

It is pointed out that the change in refractive index with temperature of a crystal is different from what is calculated from the accompanying change in volume and the piezo-optic coefficients. The difference, which is a pure temperature effect, is explained as being due to the change in polarizability of the atoms produced by a change in the amplitude of vibration. The polarizability (α) can be expanded as a Taylor series in the changes of the distance (r) between the atoms and it is found that while the piezo-optic coefficient depends only on $\partial\alpha/\partial r$, the pure temperature effect is a function of $\partial^2\alpha/\partial r^2$. Making use of the experimental data, the values of α and its first two derivatives can be determined. These values are found to be of the same order as those deduced from the intensities of Rayleigh and Raman scattering of light. The theory predicts that dn/dT should vary as the coefficient of cubical expansion at different temperatures and this is verified to be true. Finally, calculations are made of the thermo- and piezo-optic coefficients, considering the electrostatic interaction between the atoms. These do not adequately explain the observed facts, since no provision is made for the distortion of electron atmospheres around the atoms and the consequent changes in polarizability. A.

548.24 : 539.373

4729. Twin formation in cadmium. N. THOMPSON AND D. J. MILLARD. *Phil. Mag.*, **43**, 422–40 (*April*, 1952).

Experiments on the formation of twins in single crystal wires of cadmium under tension demonstrate the essentially discontinuous nature of the process of twin growth, and produce evidence in favour of a critical resolved shear stress law for twinning. Twinning can contribute to creep at room temperature but not at 90° A. A dislocation mechanism for the growth of a twin is discussed in some detail. A.

548.5

4730. Growth of alkali halides from the vapor on single-crystal substrates of alkali halides. L. G. SCHULZ. *Acta Cryst.*, **5**, 130–2 (*Jan.*, 1952).

Alkali halides of the sodium chloride type structure

(LiF, NaF, LiCl, KF, NaCl, NaBr, KCl, KBr, KI and RbI) were deposited from the vapour phase by evaporation in a vacuum on to cleavage surfaces of LiF, NaCl, KCl and KBr. It was found by electron diffraction that the crystals of the initial deposit were oriented with their crystallographic axes parallel to those of the substrate for all deposit–substrate combinations. Through the examination of deposits which had an average thickness of only a few atomic layers, the mechanism of crystallization of the initial deposit was determined. A.

548.5

4731. Influence of foreign cations in solution upon the crystalline faces of precipitated gypsum. H. Forestier and G. Krémer. *C.R. Acad. Sci.* [*Paris*] **234,** 941–3 (*Feb.* 25, 1952) *In French.*

Foreign cations (e.g. Al^{+++}) favour precipitation of gypsum from an aqueous solution of $CaCl_2$ by H_2SO_4 in the form of tabular parallelopipeds as against the usual precipitation of fine needles. The percentage of the tabular form in the total precipitate increases with the electrical superficial density of the foreign cation. H. H. HODGSON

548.5

4732. Spiral growth of crystals of biotite. S. Amelinckx. *C.R. Acad. Sci.* [*Paris*] **234,** 971–3 (*Feb.* 25, 1952) *In French.*

Franks' mechanism [Abstr. 1343 (1950)] is proved with measurements on the (001)-face of a crystal of meroxene, using a thin silver layer, showing up level differences of 7 Å. C. TURNER

548.5

4733. Growth-rates of single crystals of ethylene diamine *d*-tartrate: flawed growth and its inhibition by boric acid. A. H. Booth and H. E. Buckley. Letter in *Nature* [*Lond.*] **169,** 367–8 (*March* 1, 1952).

The rate of growth is strongly dependent on temperature, independent of face dimensions, but flawed faces grow faster than unflawed ones. Substances that decrease the rate of growth increase the rate at which it can grow unflawed. Most effective is a boric acid solution of 0·2–0·6 g/l. Higher concentrations form other faces, and rounded ones. C. TURNER

548.5

4734. Growth figures on crystals of silicon carbide. A. R. Weill. *C.R. Acad. Sci.* [*Paris*] **234,** 1068–70 (*March* 3, 1952) *In French.*

Photomicrographs show spiral growth curves in accordance with the theory of Burton, Cabrera and Frank [Abstr. 6560 (1951)]. A. R. STOKES

548.5

4735. Growth spirals on hæmatite (Fe_2O_3) crystals. A. R. Verma. Letter in *Nature* [*Lond.*] **169,** 540–1 (*March* 29, 1952).

Hæmatite is isomorphic with corundum, and the oxygen is in hexagonal close packing. The growth spirals are triangular in the centre, soon becoming hexagonal. X-ray measurements of the layer-repeat, and interference measurements of the height between successive steps of the spiral agree within the limits of error. C. TURNER

54

4736. The growth of cadmium iodide crystal II. A study of the heights of growth steps on cadmiu iodide. A. J. Forty. *Phil. Mag.*, **43,** 377–92 (*Apr* 1952).

For Pt I, see Abstr. 2237 (1952). Several metho for measuring step-heights on crystal surfaces a described. The measurements of small growth ste (< 500 Å high) on cadmium iodide, by an interr interference method, show that the theory of form tion of large screw dislocation groups, based on "buckle, followed by slip" hypothesis, is probabl correct. Dislocation groups having Burgers' vecto equal to any integral number of minimal sandwic layer thicknesses can be expected, but even valu occur with much greater frequency. It has bee shown that the occurrence of "odd" dislocatio groups indicates polytypism in cadmium iodid crystals.

548.

4737. Further observations of growth patterns o silicon carbide (Si–C) crystals. A. R. Verma. *Phi Mag.*, **43,** 441–6 (*April*, 1952).

Reports further observations of growth patterns o silicon carbide crystal faces using techniques pre viously described [Abstr. 9810 (1951)]. In additio to the simple types of spirals in which the step height was shown to be equal to the height of an X-ray uni cell, spirals originating from dislocations of multipl strength, the step height being a multiple of th height of an X-ray unit cell, are reported. Mor complex geometrical growth patterns of groups o dislocations are illustrated. The conditions for th interaction of growth fronts issuing from a numbe of dislocations are discussed and shapes of the loc of points of intersection of such growth fronts ar calculated and illustrated. It is observed that i any one region of the crystal, the screw dislocation are not only predominantly of the same sign bu have also the same strength. A

548.5 : 537.312.

4738. Oxygen-free single crystals of lead telluride selenide, and sulfide. W. D. Lawson. *J. Appl. Phys.* **23,** 495–6 (*April*, 1952).

Anomalies in the type of conductivity of artificially prepared crystals of PbSe and PbTe have been found to be the result of the presence of O. A method has been developed for eliminating O from the specimens by melting the elements into the crucible in an atmosphere of H. It has also been found possible to grow single crystals of PbS when O is eliminated from the specimen in this way. A

548.5 : 537.54

4739. On the preparation of stilbene crystals. R. F Leininger. *Rev. Sci. Instrum.*, **23,** 127–9 (*March* 1952).

A method of preparing large stilbene crystals suitable for use in scintillation counters is presented. A

548.52

4740. Influence of the rate of evaporation of aqueous solutions of alkali halogenides on the appearance of the precipitated crystals. R. Kern. *C.R. Acad. Sci* [*Paris*] **234,** 970–1 (*Feb.* 25, 1952) *In French.*

A drop of solution has been evaporated at 25

nd at higher temperatures, at different vapour ressures. A slow rate showed for all solutions (100). ctahedral forms appear at increasing rates, mainly r LiF and NaF, cubes for NaCl, KCl, KBr and KJ. or NaF (*ppr*), (*pqq*), (*Oqr*) have been found. There a close connection between the crystal forms and ie rate of evaporation. C. TURNER

548.524 : 539.373

4741. Growth twins in cadmium. D. S. OLIVER. etter in *Research* [*Lond.*] **5**, 45–6 (*Jan.*, 1952).

During the growth of flat single crystals of Cd by ndrade and Roscoe's method additional crystals ere found to develop, appearing to start from oints on one of the specimen surfaces, and bearing the majority of cases a twin relationship to the riginally solidified crystal. Such twins, produced ossibly by stresses set up during solidification, may row or remain as small included grains according s the orientation is more or less favourable for rowth than the mother crystal. These small included wins are suggested, as an alternative to stacking aults, as possible sources of deformation twins.

A. D. LE CLAIRE

548.524 : 541.64

4742. Crystallization and melting of linear high olymers as rate processes. A. OOKAWA. *J. Phys. oc. Japan*, **6**, 473–8 (*Nov.–Dec.*, 1951).

It is characteristic with the crystalline solid of inear high polymers that the regular crystalline egions and the irregular entangled regions are mixed o form the spherulitic particles. On this basis the ate of crystallization is estimated as a function of the rystallization temperature, in line with the usual reatment on the formation of a new phase. The nelting temperature in the process of heating the rystallized specimen at uniform rate is determined, n the supposition that melting is observed at a emperature where the rate of melting becomes omparable with the heating rate. The theoretical esults are fairly in accordance with the observations n natural raw rubber. Some discussions are included elevant with the appropriateness of the model. A.

548.53

4743. On the rate of nucleation in the recrystalliza-ion. T. YOKOBORI. Note in *J. Phys. Soc. Japan*, **6**, 404–5 (*Sept.–Oct.*, 1951).

The rate of nucleus formation is constant after a hort incubation time. The value is dependent on emperature, prior plastic deformation, and grain umber per unit area of the specimen. C. TURNER

548.53

4744. Mechanism of precipitation of α from β in 50:40 brass. G. SHINODA AND Y. AMANO. *J. Phys. Soc. Japan*, **6**, 508–12 (*Nov.–Dec.*, 1951).

Body-centred cubic β brass, containing *c.* 40% Zn, btained by quenching from 850° ~ 900°C shows eversal processes of Kurdjumow and Sachs type ransformation during tempering. Various inter-mediate structures between β and face-centred cubic α were ascertained by means of X-ray analysis using capillary and ordinary X-ray tubes. Such are body-centred and face-centred tetragonal structures having various axial ratios; therefore the transformation must take place in a gradual manner, although the formation of martenstic needles is well known. The decrease of solubility of Zn in α solid solution due to lowering of the temperature, determined from X-ray data, is more significant than that of Konobejewski. A.

548.53 : 539.374

4745. The influence of crystal orientation on polygonization of aluminium single crystals. W. G. BURGERS, Y. H. LIU AND T. J. TIEDEMA. *Proc. K. Ned. Akad. Wet. B*, **54**, 459–63 (*No.* 5, 1951).

Laue photographs of single crystal strips of various orientations were taken after each had been extended 10%. Each was then annealed for successive periods and the structural changes occurring studied by the focusing Laue method [Abstr. 7439 (1951)].

It was found that crystals of those orientations which enabled a large number of glide combinations to operate, and therefore showed no pronounced asterism, polygonized much more readily than those which showed asterisms, revealing a dependence of polygonization on the orientation of the crystal with respect to the direction of the deformation. A tentative suggestion is made to account for this dependence. A. D. LE CLAIRE

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

4746. A plea for the proper use of the Hermann–Mauguin space-group symbols. A. J. C. WILSON. Note in *Acta Cryst.*, **5**, 145–6 (*Jan.*, 1952).

These symbols are explicit about the orientation of the essential symmetry elements of the space groups. Confusion can arise if the symbol for the usual orientation is written when the actual orientation is non-standard. For example, *Pna* should not be used when $P2_1cn$ is meant. A. J. C. WILSON

548.7

4747. Structure and properties of ice. I. Position of the hydrogen atoms and the zero-point entropy. II. Change in configuration and molecular turns. III. Ionisation of ice and molecular turns produced by the ions. The proton jump conductivity of ice (and water). N. BJERRUM. *K. Danske Vidensk. Selsk. Mat.-fis. Medd*, **27**, 56 *pp.* (*No.* 1, 1951).

I. Ice crystallizes hexagonally. From the bond energy it is concluded that 99·9% of the hydrogen atoms are in inverse mirror and oblique centre symmetric positions at 90°K. Thus the zero-point entropy should be 1/100th of Pauling's value 0·806 kcal/g mol/degree. Experiments show 0·82. No explanation is given.

II. Rotation over 90° of the dipole moments of molecules near fault-sites in the ice-crystal causes the dielectric constant. The energy of activation for these rotations is calculated at 12·7 to 16·1 kcal/gmol, agreeing with Debye's values. The rate of rotation is estimated at $4{\cdot}8 \times 10^{11}$ turns per sec at 0°, and the concentration of the fault sites 1 in 10^6.

III. The conductivity in ice under different conditions is considered theoretically as due to migration

of H_3O^+ and OH^- ions by proton jumps between ions and uncharged molecules. The rate of these in ice is calculated at 152 per H_2O molecule, $4{\cdot}15\times10^{11}$ per H_3O^+ ion and $1{\cdot}6\times10^{11}$ per HO^- ion per sec at 0°. C. TURNER

548.7

4748. On elastic waves in cubic lattices. H. GERSTENKORN. *Ann. Phys.* [*Lpz.*] **10,** 80–93 (*No.* 1–2, 1952) *In German.*

A monatomic cubic lattice is considered. Special attention is paid to the conditions which hold for long wavelengths and to the relationship between the elastic properties of the crystal and the coupling between the atoms. P. T. LANDSBERG

548.7

4749. Speculations on the properties of the silver halide crystals. F. SEITZ. *Rev. Mod. Phys.*, **23,** 328–52 (*Oct.*, 1951).

The available experiments on the absorption spectra, photoelectric, and photolytic properties of the silver halide crystals are re-analysed and interpreted. The conclusions drawn may be regarded in the nature of extensions of the Gurney–Mott theory of photolytic action. The principal speculative viewpoints are as follows: 1. The characteristic absorption spectra of the pure salts derive much of their structure from forbidden optical transitions associated with lattice distortion arising from dislocations. In materials prepared from the melt the dislocations may be formed by condensation of lattice vacancies associated with about 1·0% of Schottky defects. 2. Some of the absorption structure may be associated with "forbidden" $d^{10}\rightarrow d^9s$ transitions in the Ag ions. 3. The electron traps which are responsible for the early deposits of photolytic Ag may be incipient halogen-ion vacancies which have an effective charge $+e/2$. These vacancies occur at jogs in dislocation lines, where such lines pass from one slip plane to a parallel plane, and may be enhanced by plastic flow. Incipient positive-ion vacancies, having an effective charge $-e/2$, also occur and act as nuclei for forming halogen clusters whose absorption bands are hidden behind the fundamental band. 4. At room temperature, the photoelectrons may be trapped by interstitial Ag ions before ending at incipient halogen-ion vacancies; however this process represents only a temporary delay since the entire Ag atom may migrate to the dislocation. 5. The addition of S to the Ag halides may play a role in enhancing darkenability in three ways: (*a*) By forming precipitates which produce distortion that enhances the number of incipient vacancies; (*b*) by extending the absorption spectrum toward the red end of the spectrum; and (*c*) by increasing the equilibrium density of interstitial Ag ions. 6. The luminescent radiation observed in pure Ag halides by Farnell, Burton and Hallama may arise from transitions within the Ag ion. The emitting ions are at dislocations in AgCl and AgBr. A sequence of experiments is suggested. A.

548.7 : 535.343.2

4750. On the colouration of compressed rock salt crystals by irradiation with alpha particles from RaF. L. WIENINGER. *S.B. Ost. Akad. Wiss. IIa,* 15[illegible] 381–93 (*No.* 9–10, 1950) *In German.*

Coloration is more rapid in compressed crysta[illegible] than in uncompressed crystals, and experiments sho[illegible] that the energy of formation of *F*-centres in the[illegible] crystals is much lower than in the uncompresse[illegible] state (about 8 eV per centre). In these crystals th[illegible] *F*-centres are not stable at ordinary temperatur[illegible] and an absorption band at 670 mμ is found. *R*[illegible] centres with absorption at 510 mμ form in the dar[illegible] at room temperature. In such perturbed crystals th[illegible] stability of *F*-centres is related to the degree of pe[illegible] turbation. The saturation level of coloration always less in the perturbed crystals than in thos[illegible] uncompressed. G. F. J. GARLIC[illegible]

548.7 : 535.343.[illegible]

4751. On the influence of heating on the absorption spectrum of rocksalt coloured by RaF alpha particles. L. WIENINGER AND N. ADLER. *S.B. Ost. Akad. Wiss. IIa,* **159,** 395–406 (*No.* 9–10, 1950) *In German.*

Heating rock salt coloured yellow by α-particle[illegible] changes the colour to blue, and experiments sho[illegible] that R_2-centres are formed from *M*- and *F*-centres[illegible] Centres with absorption at 670 mμ are found i[illegible] compressed salt and the absorption at 510 mμ i[illegible] identified with R_2-centres. The different tones of blu[illegible] in naturally coloured rock salt are due to differen[illegible] intensities of the 670 and 510 mμ bands. The reaction kinetics for formation of the R_2-centres follow the van't Hoff law from 183–230°C (see also preceding abstract). G. F. J. GARLICK

548.7 : 535.343.2

4752. Red hydrogen chloride. W. H. JOHNSTON AND R. E. MARTIN. Letter in *J. Chem. Phys.*, **20,** 534 (*March*, 1952).

When rapidly solidified in liquid nitrogen HCl exhibits a transient red colour due to imperfection colour centres, and unaffected by possible impurities other than nitric oxide. C. TURNER

548.7 : 535.343.2 : 541.14

4753. Rate of coagulation of *F*-centres in KCl. F. E. THEISEN AND A. B. SCOTT. Letter in *J. Chem. Phys.*, **20,** 529 (*March*, 1952).

The decrease in concentration of *F*-centres with time is shown at several temperatures in darkness and with 560 mμ illumination. The acceleration by illumination can be explained by ionization of *F*-centres or catalysis by photochemically formed *R*-centres. C. TURNER

548.7 : 535.375.5

4754. Position of the C=O bond in the crystals of oxalic acid dihydrate. L. COUTURE-MATHIEU AND L. BARDET. *C.R. Acad. Sci.* [*Paris*] **234,** 931–3 (*Feb.* 25, 1952) *In French.*

The crystal structure of oxalic acid dihydrate proposed by Brill [*Z. Elektrochem.*, **50,** 47 (1944)] is confirmed by investigation of its Raman spectrum. G. I. W. LLEWELYN

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 4651–9

548.733

755. Arrangement to suppress the asymmetry of iagrams due to the height of the beam coming from a onochromator. A. GUINIER AND R. GRAF. Note in *Acta Cryst.*, **5**, 150 (*Jan.*, 1952) *In French.*

Film and specimen rotate around the mean ray of ne primary beam, behind a screen with an opening f 30°. C. TURNER

548.734

756. An illustration of the optical basis of Wilson's -ray method for detecting centres of symmetry. . A. TAYLOR. Note in *Acta Cryst.*, **5**, 141–2 (*Jan.*, 952).

See Abstr. 6562 (1949). It is easy to distinguish isually the optical diffraction patterns of centro-ymmetrical objects from those of non-centro-ymmetrical objects. A. R. STOKES

548.734

757. A simplified fly's eye procedure. A. W. IANSON AND H. LIPSON. Note in *Acta Cryst.*, **5**, 145 *Jan.*, 1952).

Instead of using a grating consisting of several undred elements it is sufficient and even advantageous o use only four. A. R. STOKES

548.734.3

758. A procedure for simultaneous determination f effective film radius and error of setting in a Veissenberg camera. H. FISCHMEISTER. *Acta Phys. lustriaca*, **5**, 254–7 (*No.* 2, 1951) *In German.*

As the usual methods of calibration cannot be sed, a modified method is given; an accuracy of part in 10 000 in lattice spacings is claimed.

A. R. STOKES

548.734.8

759. Analysis of certain errors in the X-ray eflection method for the quantitative determination of referred orientations. W. P. CHERNOCK AND P. A. ECK. *J. Appl. Phys.*, **23**, 341–5 (*March*, 1952).

The reflection method for quantitative determina-ion of pole figures, proposed by Schulz, proved to e limited with respect to the range of tilting angles n which satisfactory results can be obtained. It is hown that the previously unexplained decrease in he diffracted intensity with increasing tilting angle or specimens with random orientation distribution an be accounted for on the basis of an elementary nalysis of defocusing effects. Experimental evidence s presented to show that variation of the receiving lit length and of the main slit width has the effect redicted by the analysis. The importance of accurate pecimen alignment is discussed and a satisfactory lignment check procedure is described. A.

548.734.8

760. Crystal diffraction of X-rays by elastic aves: experimental study of quartz crystals in scillation. J. GUILLAUME. *C.R. Acad. Sci.* [*Paris*] **34**, 1071–2 (*March* 3, 1952) *In French.*

The integrated intensities of reflection of the $11\bar{2}0$, $22\bar{4}0$ and $33\bar{6}0$ orders were found to be increased wo- or threefold when the crystal was vibrating at 780 kc/s. A. R. STOKES

548.735

4761. A method of deriving crystal geometry from random rotation photographs. H. J. GRENVILLE-WELLS. Note in *Acta Cryst.*, **5**, 147–8 (*Jan.*, 1952).

From the multiplicity of reflections with the same Bragg angle the Laue symmetry group may readily be found. A. R. STOKES

548.735 : 518.3

4762. Charts for the interpretation of rotation and Weissenberg photographs. G. DONNAY AND J. D. H. DONNAY. *Rev. Sci. Instrum.*, **23**, 130–2 (*March*, 1952).

Two charts are presented. The first one gives, from a rotation photograph, the direct lattice translation of the rotation axis. From a zero-layer undistorted Weissenberg photograph, the second chart gives the reciprocal lattice translations perpendicular to the rotation axis. The nomographs are constructed for the standard camera radius ($R = 180/2\pi$ mm), but they can be used with any wavelength. A.

548.735.44

4763. The squaring method: a new method for phase determination. D. SAYRE. *Acta Cryst.*, **5**, 60–5 (*Jan.*, 1952).

A new set of relationships is given which exist among the structure factors of crystals composed only of like atoms and which hold approximately for ordinary organic crystals containing only C, N. O and H. They are the consequence of the similarity between the electron-density function $d(\bar{x})$ and its square, $d^2(\bar{x})$, for such crystals. In spite of considerable differences in form, the relationships found make the same general statement about the structure factors as do the Harker–Kasper–MacGillavry and Karle–Hauptmann–Goedkoop relationships, namely that the phase of $F(a + b)$ is closely related to that of $F(a)$ $F(b)$. Because the present relationships apply to a special case (like atoms) and include the condition of a minimum separation of atoms, they should be a more powerful method for phase determination than the other methods, but this fact has not yet been demonstrated directly. The method has been applied to the structure of hydroxyproline, where it was possible in a few days to find the signs of 31 structure factors, of which 30 were correct, and to produce a Fourier projection in which the molecule was easily recognizable. A.

548.735.44

4764. A relation between the signs of structure factors. W. COCHRAN. *Acta Cryst.*, **5**, 65–7 (*Jan.*, 1952).

By considering the extent to which a partial Fourier series, which contains as coefficients only a few of the larger structure factors, will represent the electron density in a crystal structure, and using the relations between the structure factors of an electron distribution and those of the square of this distribution, a probable relation between the signs of structure factors is deduced. The relation is suggested by the form of Sayre's equality, and is also related to Harker–Kasper inequalities. A.

548.735.44

4765. A new analytical method for solving complex crystal structures. W. H. ZACHARIASEN. *Acta Cryst.*, **5**, 68–73 (*Jan.*, 1952).

With the aid of an identity it is shown that relationships between signs of structure factors for centrosymmetrical crystals can be obtained even when the Harker–Kasper inequality considerations yield no useful information. It is shown that a structure determination can be formulated as a self-consistency problem with respect to these relationships, and it is indicated how the solution can be found. The new method is successfully tested on a structure where other methods had failed. The test consisted in finding the 27 degrees of freedom for O and B atoms in the structure of the monoclinic form of metaboric acid. The results of the structure determination are briefly given. A.

548.735.44

4766. On the correction of the Fourier transform of a Debye–Scherrer line in the measurement of crystal dimensions. E. F. BERTAUT. *Acta Cryst.*, **5**, 117–21 (*Jan.*, 1952) *In French.*

Methods of correction are described and attention is drawn to the particular importance of the effect of finite summation. A.

548.735.44 : 518.5

4767. The computation of Fourier syntheses with a digital electronic calculating machine. J. M. BENNETT AND J. C. KENDREW. *Acta Cryst.*, **5**, 109–16 (*Jan.*, 1952).

Programmes have been devised for computing Patterson and Fourier syntheses in 2 and 3 dimensions with the EDSAC. An outline of the methods used is given and future possibilities are discussed. At present a 2-dimensional summation of about 400 independent terms for about 2000 points takes 1½ hr; a 3-dimensional summation of 2000 terms for 18 000 points takes 9 hr. A method is described whereby the EDSAC, without special modification, can be made to print results directly in contour form with considerable economy in time. A.

548.735.44 : 518.5

4768. A Fourier electron-density balance. V. VAND. *J. Sci. Instrum.*, **29**, 118–21 (*April*, 1952).

A calculating machine based on a torque summation by weighing, capable of carrying out X-ray crystallographic Fourier electron-density syntheses, is described. The machine consists of a gearbox driving 140 Fourier term units, each carrying an eccentric weight proportional to the structure factor. The pivoted frame carries a mirror reflecting a beam of light on to a scale, on which is read the resulting torque, which is proportional to the sum of the products of the weights and the cosines of the angles through which they have been turned. A 2-dimensional electron-density contour map can be plotted in less than six hours, including setting time. A.

548.735.46

4769. Finding the signs of the *F*'s from the shifted Patterson product. D. MCLACHLAN, JR AND D. HARKER. *Proc. Nat. Acad. Sci.* [*Wash.*] **37**, 846–9 (*Dec.*, 1951).

The relation between the profiles of peaks in Patterson and Fourier syntheses is discussed, on assumption of a Gaussian charge distribution in atoms. It is found that the square of a Patters peak has the same half-breadth as the Fourier pea If, further, the structure is centrosymmetric, the ato are all approximately the same, and one interaton vector corresponding to a pair of atoms related the centre of symmetry can be identified, this res can be used to derive an equality giving $F(hkl)$ terms of all the $|F|^2$'s, thus determining its sign. T equality is rather complex and involves the constan of the Gaussian charge distribution. A. J. C. WILS

548.736

4770. Diffraction effects observed in diamond in t vicinity of the collimated incident beam. H. GRENVILLE-WELLS. Note in *Acta Cryst.*, **5**, 146 (*Jan.*, 1952).

Experimental evidence is obtained for doub reflection of X-rays by the (111) planes of diamon A. R. STOK

548.736.1 , 536.413 , 539.155

4771. Lattice parameters, coefficients of therm expansion, and atomic weights of purest silicon an germanium. M. E. STRAUMANIS AND E. Z. AK *J. Appl. Phys.*, **23**, 330–4 (*March*, 1952).

Lattice parameter determinations of 99·97% pu Si (containing 0·03% C) were carried out using th asymmetric method, a 64 mm precision camera in thermostat at constant temperatures (10, 20, 30, 4 and 50°c). The powder mounts, about 0·12 mm dia were translated and rotated during the exposure Only the (444) Cu $K\alpha_1$ line was used for the deter minations. The lattice parameter $a = 5{\cdot}41991 \pm 0{\cdot}00003$ kX (5·43086 Å) at 20°c, corrected fo refraction, was obtained; the linear lattice expansio coefficient (between 10 and 50°c) was $4{\cdot}15 \times 10^{-6}$ the density at 20°c was $2{\cdot}32831 \pm 0{\cdot}00031$ g/cm (determined by the suspension method), and th atomic weight was $28{\cdot}083 \pm 0{\cdot}013$ (in agreemen with the new chemical weight 28·09) showing tha the Si crystals used, under certain limitations, wer sound although the possibility of interstitial atoms i not excluded. The lattice parameter of purest G (99·99 and 99·999%) was measured by the sam method using the (422) Cr $K\alpha_1$ and α_2 lines: $a_{20} = 5{\cdot}64607 \pm 0{\cdot}00004$ kX (5·65748 Å) for both ma terials. The expansion coefficients were $\alpha = 6{\cdot}65 \times 10^{-6}$ and $5{\cdot}92 \times 10^{-6}$, respectively. Th density was $5{\cdot}3234 \pm 0{\cdot}0025$ g/cm³ at 25°c and th calculated atomic weight $72{\cdot}593 \pm 0{\cdot}037$ in agre ment with the present chemical weight 72·60. Thu Ge crystals were sound; however, interstitial aton are possible. The precision of lattice parameter d termination was about 1 : 200 000, but in the case 99·999% Ge the precision was considerably bette This shows again that lattice constant determinatio can be performed with highest precision and witho use of any extrapolation method. The method lattice parameter determination applied is an absolu one.

548.736

4772. The structure of $TiBe_{12}$. R. F. RAEUCH AND R. E. RUNDLE. *Acta Cryst.*, **5**, 85–93 (*Jan.*, 195

$TiBe_{12}$ is hexagonal with $a_0 = 29{\cdot}44$, $c_0 = 7{\cdot}33$

= 48. There is a pseudo-cell, however, with = 4·23, C_0 = 7·33 Å, Z = 1, one Ti per pseudo it at 0, 0, 0 or 0, 0, ½, and it is the alternation tween these two positions which leads to the larger l. Idealized Be positions have been found for the eudo-cell. The structure is disordered, and though e general reason for the disorder is apparent, the rticular type of disorder observed has not been plained. The structure leads to an unusual set of sences. A.

548.736.3

773. A new superlattice in Co–Pt alloys. A. H. EISLER AND D. L. MARTIN. Letter in *J. Appl. Phys.*, , 375 (*March*, 1952).

A face-centred cubic superlattice with Co atoms on rner sites and Pt atoms on face centres has been bserved in a Co–Pt alloy containing 30 atomic % Co. he transformation temperature range is between 0–800°C. The lattice parameter of the phase sordered at 800°C is 3·829 Å, and that of the phase dered at 700°C is 3·831 Å. A. E. DE BARR

548.736.3

774. The short range orders in Cu_3Au. T. OGUCHI. *Phys. Soc. Japan*, **6**, 499–501 (*Nov.–Dec.*, 1951).

For an alloy of face-centred cubic lattice consisting A and B atoms present in the proportions 3 and 1, e short-range-order parameters for the sites of rious distances from a given atom are calculated ing the assumption of the nearest neighbour teraction at the temperatures above Curie point. he experimental results, especially the short-range-der parameter for 3rd neighbour, which is incon-stent with the result obtained by the Bragg–Williams' proximation, are explained qualitatively. A.

548.736.4

775. The crystal structure of sodium nitrite. . B. CARPENTER. *Acta Cryst.*, **5**, 132–5 (*Jan.*, 1952).

The crystal structure of $NaNO_2$ has been re-amined by X-ray methods. The general features of ie structure reported by Ziegler in 1931 are confirmed it significant changes in the shape of the nitrite ion e indicated. Fourier and least-squares refinement ad to these dimensions for the NO_2^- ion: N–O = ·23 Å, ∠ O–N–O = 116°. The significance of the ructure is discussed briefly. A.

548.736.4

776. Space group and unit cell of beryllium orohydride. A. J. STOSICK. Note in *Acta Cryst.*, **5**, 51–2 (*Jan.*, 1952).

548.736.5

777. A new complex eta-carbide. A. TAYLOR AND . SACHS. Letter in *Nature* [*Lond.*] **169**, 411 (*March* 8, 952).

A carbide with the structural formula $(Ni_{0·58}, o_{0·30}, Si_{0·12})_3$ $(Mo_{0·49}, W_{0·07}, Cr_{0·44})_3$ $(C_{0·95}, N_{0·05})$ losely analogous to the η-carbide $Fe_3(W, Mo)_3C$ has een examined. X-ray diffraction photographs show at the new carbide has a similar structure to Fe_4W_2C ut has a lattice parameter of 10·951 k X.

A. E. DE BARR

548.736.6

778. The unit cell of chrysotile. E. J. W. VHITTAKER. Note in *Acta Cryst.*, **5**, 143–4 (*Jan.*, 952).

Evidence is given in favour of the accepted monoclinic unit cell rather than the triclinic one proposed by Padurow [Abstr. 4492, 5392 (1950)]. A. R. STOKES

548.736.6

4779. Hexagonal $CaAl_2Si_2O_8$. G. DONNAY. Note in *Acta Cryst.*, **5**, 153–4 (*Jan.*, 1952).

548.737

4780. The crystal structure of the complex of hexamethylenetetramine with manganous chloride. Y.-C. TANG AND J. H. STURDIVANT. *Acta Cryst.*, **5**, 74–82 (*Jan.*, 1952).

Single crystals of the complex of hexamethylenetetramine with manganous chloride were grown in a 1 : 1 mixture of alcohol and acetone. By chemical analysis the composition was shown to correspond to the formula $MnCl_2 . 2(CH_2)_6N_4 . 2H_2O$. The structure has a pseudo unit cell with a_1 = 11·80, a_2 = 22·00 and a_3 = 7·21 Å, which contains 4 molecules. A few weak reflections require that the a_1 axis be doubled; these apparently arise from a slight collapse of the pseudo structure. The space group when the weak reflections are neglected is C_{2v}^9–$P2_1nb$. The structure has the following important features. The complex molecule is shown by the parameter values to have a centre of symmetry at the manganese atom, which lies on the common threefold axis of the two hexamethylenetetramine molecules. The Mn–Cl bonds are approximately normal to the Mn–N bonds. Both the Patterson syntheses and the Fourier projection $\rho(y, z)$ indicate that two molecules of water are present in each complex molecule, and the Mn–O bonds are approximately normal to the plane of the Mn–Cl and Mn–N bonds. The bonds about the manganese atom are thus approximately octahedrally directed. Lengths of the central bonds are Mn–Cl = 2·47, Mn–N = 2·40 and Mn–O = 2·00 Å. A.

548.737

4781. The crystal structure of β-1, 2, 4, 5-tetrabromocyclohexane. F. A. HAAK, J. L. DE VRIES AND C. H. MACGILLAVRY. *Acta Cryst.*, **5**, 83–5 (*Jan.*, 1952).

Cell dimensions are a = 7·23, b = 12·32, c = 6·36 Å, β = 110° 30′. The space group is $P2_1/c$. Three projections of electron density are given. The C six-ring has the chair configuration: all Br atoms are placed equatorially. A.

548.737

4782. The crystal structure of thiophene at −55°C. S. C. ABRAHAMS AND W. N. LIPSCOMB. *Acta Cryst.*, **5**, 93–9 (*Jan.*, 1952).

The crystal modification of thiophene in the range −38 to −98°C is orthorhombic, space group either D_{2h}^{18}–*Bmab* or the non-centrosymmetric equivalent C_{2v}^{17}–*B2ab*, with no conclusive distinction possible from the data. The crystal structure has been determined on the basis of each of these possible space groups, with the use of 3-dimensional Fourier sections based on visual intensity measurements from the entire reciprocal sphere. In *Bmab* each one of the 4 molecules occupies statistically any one of 4 equivalent positions related to one another by 2 mutually perpendicular mirror planes, both normal to the plane of the ring. In *B2ab*, these 4 positions reduce to 2 equivalent positions. These 2 possible structures show approximately equally good agreement with the observed data. The disorder has made

it unwise to attempt determination of intramolecular bond distances, but the closest intermolecular approach of 3·7 Å indicates, as expected, that no very strong binding forces are present in the crystal. The unit-cell dimensions are $a = 9{\cdot}76$, $b = 7{\cdot}20$ and $c = 6{\cdot}67$ Å. The plane of the molecule is parallel to a, and makes an angle of 47·8° with b. A.

548.737

4783. The crystal structure of 2-metanilamido-5-Br-pyrimidine. J. SINGER AND I. FANKUCHEN. *Acta Cryst.*, **5**, 99–103 (*Jan.*, 1952).

This structure and its isomorphous iodine analogue has been determined by 2-dimensional Fourier methods. These compounds are active anti-malarials. The crystals are monoclinic space group $P2_1/n$. A "subtraction Fourier" method is described which was helpful in obtaining the signs of weak reflections. The method may prove useful in cases where a heavy scatterer, used to determine the phases of the stronger reflections, obscures the detail of the lighter atoms. The analysis is based mainly on one well-resolved projection, and on a combination of the Pauling covalent radii with the essential structural features disclosed by the second, heavily overlapped, projection of the molecule. The configuration of the $-NH-SO_2^-$ linkage between aromatic rings is given for the first time. Weak hydrogen-bonding between NH_2 and oxygen atoms of SO_2, of length 3·15 Å, is indicated, with one hydrogen of the NH_2 group of one molecule directed to one of the oxygens of an adjacent molecule. A.

548.737

4784. Arrangement of polypeptide chains in horse methaemoglobin. W. L. BRAGG, E. R. HOWELLS AND M. F. PERUTZ. *Acta Cryst.*, **5**, 136–41 (*Jan.*, 1952).

The analysis in this paper is based on the assumption that the protein molecule consists for the greater part of parallel polypeptide chains in a hexagonal packing with an inter-chain distance of 10·5 Å. If this assumption is correct, the analysis assigns to the haemoglobin molecule an arrangement in which the chains, seen in end-on projection, are arranged in layers. There are 3 inner layers containing 4, 5 and 4 chains respectively of nearly equal weight. The outer layers contain only 2 or 3 chains, and each of these chains is of less scattering power than those in the inner layer. A study of the absolute intensities shows that the values of $F(0kl)$ due to the hexagonal array are one one-third of what would be expected if the polypeptide chains were straight and parallel throughout the molecule. Several factors are likely to reduce $|F(0kl)|$. The haemoglobin molecul consists of two halves joined, probably, along a plan which cuts across the chain direction. This implie that chains cannot continue in a straight line fo more than about 30 Å before being forced to turn corner. Corner turning, lack of alignment of th two halves of the molecule, non-uniformity in th distribution of the side-chains, and, perhaps, meande ing of the chains from strict parallelism would al reduce $F(0kl)$. It is too early to judge whether thi reduction would be sufficient to account for the lov observed F's or whether part of the molecule i occupied by structures other than straight chain running parallel to the a axis. A

548.737

4785. The structure of *p*-di-isocyanobenzene. R. HULME. Note in *Acta Cryst.*, **5**, 144 (*Jan.*, 1952).

548.737

4786. The crystal structure of decamethylene-diamine. A. O. MCINTOSH AND J. M. ROBERTSON. Note in *Acta Cryst.*, **5**, 149 (*Jan.*, 1952).

548.737

4787. The unit-cell dimensions and the space groups of some simple peptides of glycine, alanine and leucine. J. E. LEONARD AND R. A. PASTERNAK. Note in *Acta Cryst.*, **5**, 150–1 (*Jan.*, 1952).

548.737

4788. The unit-cell dimensions and the space groups of some alanyl peptides. R. A. PASTERNAK AND J. E. LEONARD. Note in *Acta Cryst.*, **5**, 152–3 (*Jan.*, 1952).

548.737

4789. Crystal structure of 3·4: 5·6 dibenzphenanthrene. A. O. MCINTOSH, J. M. ROBERTSON AND V. VAND. Letter in *Nature* [*Lond.*] **169**, 322–3 (*Feb.* 23, 1952).

There are two monoclinic structures, space-groups $P2_1/a$ and $A2/a$. The unit cell and molecular configuration of the second have been found; it is non-planar. A. R. STOKES

548.74

4790. On the anomalous structures of ZnO. K. TANAKA AND H. HASHIMOTO. Note in *J. Phys. Soc. Japan*, **6**, 406–7 (*Sept.–Oct.*, 1951).

Electron diffraction patterns of zinc in various stages of oxidation did not reveal the pseudomorphic ZnO reported by Finch [*Proc. Phys. Soc.* [*Lond.*] **46**, 148 (1934)]. Extra reflections observed in the intermediate stages are explicable on the basis of two intermediate phases, one related closely to Zn and the other to ZnO. R. S. PEASE

GEOPHYSICS 55

550.342

4791. A new type of surface wave from earthquakes. F. W. WOOD. Letter in *Nature* [*Lond.*] **169**, 368–9 (*March* 1, 1952).

Reports the identification of surface waves, called Z-waves, with purely vertical ground motion in the records of 42 earthquakes recorded at Harvard. Group velocities range from 3·10 km/sec for a period of 21 sec to 3·66 km/sec for a period of 35 sec and are about 0·96 times the Rayleigh wave velocities and about 0·88 times the Love wave velocities. Records from other observatories and from explosions show the same features. Since the Z-waves are a distinct type with their own group velocity it is no correct to identify Rayleigh waves by the vertica component of the ground motion. A. H. COOK

550.384

4792. Interpretation of the eleven-year variation of the horizontal component of the geomagnetic field. BERNARD. *C.R. Acad. Sci.* [*Paris*] **234,** 866–8 (*Feb.* 18, 1952) *In French.*

A study of the 11-year variation of the magnetic horizontal component at 37 stations reveals an average amplitude of about 20 γ, with a minimum occurring about 1·1 years after the maximum of solar activity. It is claimed that this variation can be accounted for by a general circulation of the atmosphere in the region between 75 and 150 km altitude, together with the change of ionization during the 11-year cycle. The atmospheric motions involved are entirely distinct from those causing the daily variations. The anomalous effect at Huancayo requires a separate explanation. A. T. PRICE

550.384

4793. Geomagnetic field variations at Kodaikanal. M. V. SIVARAMAKRISHNAN. Letter in *Nature* [*Lond.*] **169,** 409–10 (*March* 8, 1952).

Sudden commencements (SC's) recorded at Kodaikanal in 1949–51 show minima at 8 hr and 20 hr local time; this differs from the Alibag results. No SC's of the second type were recorded at Kodaikanal; SC's of this type at Huancayo were of the first type at both Kodaikanal and Alibag. Some SC's recorded at Kodaikanal were not recorded at other observatories. Crochets invariably exhibit a positive H variation and usually a negative V variation, but sometime V is positive; this is similar to what occasionally happens in the daily variations.

A. T. PRICE

550.384

4794. Sudden commencements preceded by the preliminary reverse impulse in a geomagnetic field. T. NAGATA. *Nature* [*Lond.*] **169,** 446–7 (*March* 15, 1952).

The variation with local time and geomagnetic latitude of the mean value of p/m, where p is the magnitude of the preliminary reverse impulse and m that of the main impulse, is determined for 67 magnetic storms occurring during 1946–7, using the data published by the U.S. Coast and Geodetic Survey for 5 American stations. The results indicate that p/m has a maximum near 16 hr local time, and its magnitude increases markedly with geomagnetic latitude, being especially large near the auroral zone. A study of several individual storms, using many more stations, confirms these results. A. T. PRICE

550.384.08 : 538.082.74

Analysis of the variation of magnetic flux by means of parallel-connected fluxmeters. *See Abstr.* 4460

ATMOSPHERE . METEOROLOGY 551.5

551.510.3

4795. Molecular density measurements of the atmosphere up to 61·5 km by means of the searchlight technique. J. R. BAUER. *Mixed Commission on Ionosphere, Brussels* (1950) 85–95. [See Abstr. 4798 (1952)].

An extremely sensitive photoelectric receiver was used to measure the atmospheric scattering of light from a searchlight beam and the results used to determine the molecular density up to 61·5 km and the temperature distribution up to 53 km.

W. J. G. BEYNON

551.510.5

4796. The mechanism of the earth's atmosphere. Y. ISIMARU. *Geophys. Mag.* [*Tokyo*] **21,** 269–301, 303–42 (*Aug.*, 1950).

The earth's atmosphere is regarded as an ellipsoid balancing gravity against centrifugal force. The heat balance is determined by temperature difference equator-pole; mean lapse rate is represented by this/height of tropopause, giving a calculated value of 0·55°/100 m. Relation between height and temperature of tropopause is discussed; tropopause is an oblate ellipsoid of eccentricity 1/579. Seasonal variation and annual mean temperature at earth's surface are discussed mathematically, including effect of land and sea distribution and ocean currents. In Pt II author regards surface as a sphere; apparent centre of gravity 128 km from geometric centre. He calculates shape and temperature distribution of troposphere, ozonosphere and ozonopause (about 50 km) and ionosphere. Results are in good agreement with those obtained by other methods up to 150 km and he extends his calculations to 300 km for latitude 0–90°. METEOROLOGICAL ABSTRACTS

551.510.535

4797. Seasonal variation of the minimum frequency in h'–f curve for the "E" ionospheric region. H. KAMIYAMA. *Sci. Rep. Tohoku Univ., 5th Ser. Geophys.*, **2,** 79–85 (*Aug.*, 1950).

The minimum critical frequency in the E layer at noon is found to be proportional to $\cos^{\frac{3}{4}}$ (zenith distance of sun at noon). This supports the existence of an ionized D layer about 55 km and variations from the cos-law may give information about temperature in the middle stratosphere.

METEOROLOGICAL ABSTRACTS

551.510.535

4798. Mixed Commission on Ionosphere, International Council of Scientific Unions. Proceedings of Second Meeting, Brussels, September 4–6, 1950. *Secrétariat Général de l'U.R.S.I.*, 42 *Rue des Minimes, Brussels* (1951) 230 *pp.*

The first part deals with the full proceedings and discussions at the five sessions held, together with the Commission's proposals concerning an International Polar Year in 1957–58 and also with the organizing of radio observations during the solar eclipse of February 25, 1952. The specific topics considered and the introductory speakers were: *The formation of the ionosphere.* H. S. W. Massey (9–31). *Movements in the ionosphere.* D. F. Martyn (31–8). *A new theory of solar activity and solar terrestrial relationships.* D. H. Menzel (38–44). *Sporadic E ionisation.* D. F. Martyn (44–8). *Magnetic storms and aurorae. Solar particles at the earth.* D. F. Martyn (49–58).

The latter part contains 28 papers submitted to the commission.

Ionosphere composition; physical properties, etc.:—*New important facts relating to the composition and state of the ionosphere derived from auroral studies.* L. Vegard (79–81). *Characteristics of the night sky at College, Alaska.* J. B. Wilcox (81–4) [Abstr. 4813 (1952)]. *Molecular density measurements of the atmosphere up to 61·5 km by means of the searchlight technique.* J. R. Bauer (85–95) [Abstr. 4795 (1952)]. *Ionospheric temperatures.* N. C. Gerson (95–9).

Movements in the ionosphere:—*The semi-diurnal lunar variations in the F2 layer.* Y. Hagihara (99–100) [Abstr. 4799 (1952)]. *Lunar stratification of the F2 layer at Huancayo, Peru.* T. N. Gautier, R. W. Knecht and A. G. McNish (100–5). *Tides in the F-layer.* M. W. Jones and J. G. Jones (105–7). *Report on tidal movements in the F-layer relative to tidal variations of surface pressure.* M. W. Jones and J. G. Jones (107–9). *Wind systems and longitudinal variations of critical frequency in the F-layer.* D. G. Yerg (109–12) [Abstr. 4800 (1952)].

Ionospheric irregularities:—*Ionospheric storms.* T. Nagata and N. Fukushima (112–13) [Abstr. 4801 (1952)]. *Sporadic E ionisation.* K. Rawer (114–19) [Abstr. 4802 (1952)]. *Long-distance communication over north-south paths on 50 Mc/s.* E. P. Tilton (119–20) [Abstr. 4492 (1952)]. *Sporadic E investigations.* N. C. Gerson (121–5). *On the definition of the E2 layer.* W. Becker and W. Dieminger (126–38).

F2-layer anomalies:—*On the world-wide distribution of f_0F2.* H. Uyeda (138–40) *Anomalies of region F2.* K. Rawer (140–4). *The influence of the earth's magnetic field on the F2 layer.* O. Burkard (145–54). [Abstr. 4803 (1952)].

General:—*Geomagnetic variations and ionospheric current systems.* T. Nagata, N. Fukushima and M. Sugiura (154–6) [Abstr. 4804 (1952)]. *A 27-day recurrence tendency in the normal E-layer critical frequency.* W. J. G. Beynon and G. M. Brown (156–61) [Abstr. 4805 (1952)]. *Studies of the ionosphere using very long wave pulse techniques.* A. H. Waynick (161–5) [Abstr. 4806 (1952)]. *Ionospheric wave propagation at low frequencies.* J. Feinstein (166–75) [Abstr. 4493 (1952)]. *Ionospheric and meteorological changes in the period January–April 1949.* W. J. G. Beynon and G. M. Brown (175–81). *Magnetic ionic triple splitting.* O. E. H. Rydbeck (182–201). *Triple splitting in a regular layer.* H. J. Groenewold (201–5) [Abstr. 4807 (1952)]. *On some results of ionosphere study.* T. Yonezawa (206–7) [Abstr. 4808 (1952)]. *Higher order approximations in ionospheric wave propagation.* J. Feinstein (207–15). *On the electrical conductivity of the upper atmosphere.* K. Maeda (215–27) [Abstr. 4814 (1952)]. *Excitation processes of night sky and auroral spectra.* S. N. Ghosh (227–30).

[The articles to which no abstract numbers are attached are also published elsewhere, and are abstracted independently.] W. J. G. BEYNON

551.510.535

4799. The semi-diurnal lunar variations in the *F2* layer. Y. Hagihara. *Mixed Commission on Ionosphere, Brussels* (1950) 99–100. [See Abstr. 4798 (1952)].

The average amplitude and phase for the height of maximum ionization in *F2* in Japan are given as 3·3 km and 256° respectively. W. J. G. BEYNON

551.510.533

4800. Wind systems and longitudinal variations of critical frequency in the *F*-layer. D. G. Yerg. *Mixed Commission on Ionosphere, Brussels* (1950) 109–12 [See Abstr. 4798 (1952)].

A possible wind circulation within the ionosphere is proposed and related to the distribution of *F2* ionization. W. J. G. BEYNON

551.510.535

4801. Ionospheric storms. T. Nagata and N. Fukushima. *Mixed Commission on Ionosphere, Brussels* (1950) 112–13. [See Abstr. 4798 (1952)].

Short note on the statistics of their appearance and relation to geomagnetic storms. W. J. G. BEYNON

551.510.535

4802. Sporadic *E* ionisation. K. Rawer. *Mixed Commission on Ionosphere, Brussels* (1950) 114–19. [See Abstr. 4798 (1952)].

Existing methods of defining fE_s are criticized and a new method proposed. Evidence is quoted to show that the *Es* layer is not a thin homogeneous layer, but rather consists of many small clouds of ionization. W. J. G. BEYNON

551.510.535

4803. The influence of the earth's magnetic field on the *F2* layer. O. Burkard. *Mixed Commission on Ionosphere, Brussels* (1950) 145–54 *In German.* [See Abstr. 4798 (1952)].

Local temporal variations in the ionization of the *F2* layer are studied and formulae derived relating f_0F2 to solar angle, magnetic field intensity and geographical latitude. W. J. G. BEYNON

551.510.535

4804. Geomagnetic variations and ionospheric current systems. T. Nagata, N. Fukushima and M. Sugiura. *Mixed Commission on Ionosphere, Brussels* (1950) 154–6. [See Abstr. 4798 (1952)].

Short discussion on various ionospheric problems associated with the S_q and S_D field. W. J. G. BEYNON

551.510.535

4805. A 27-day recurrence tendency in the normal *E*-layer critical frequency. W. J. G. Beynon and G. M. Brown. *Mixed Commission on Ionosphere, Brussels* (1950) 156–61. [See Abstr. 4798 (1952)].

A well-marked 27-day variation in fE has been detected showing no significant phase difference between it and the corresponding variations in sun-spot number data. W. J. G. BEYNON

551.510.535

4806. Studies of the ionosphere using very long wave pulse technique. A. H. Waynick. *Mixed Commission on Ionosphere, Brussels* (1950) 161–5 [See Abstr. 4798 (1952)].

Summary of the theoretical and experimental work at Pennsylvania State College, since February 1949. W. J. G. BEYNON

551.510.535

4807. Triple splitting in a regular layer. H. J. ROENEWOLD. *Mixed Commission on Ionosphere, Brussels* (1950) 201–5. [See Abstr. 4798 (1952)].

A short mathematical treatment of the phenomenon, having limited application, is outlined.

W. J. G. BEYNON

551.510.535

4808. On some results of ionosphere study. T. ONEZAWA. *Mixed Commission on Ionosphere, Brussels* (1950) 206–7. [See Abstr. 4798 (1952)].

Short notes on various ionospheric problems (absorption and recombination coefficient) being studied in Japan. W. J. G. BEYNON

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 4492–5

551.521.3 : 551.501.45

4809. Tables and diagrams for calculating counter and outgoing radiation. H. M. BOLZ AND H. FRITZ. *Z. Met.*, **4**, 314–17 (*Oct.*, 1950) *In German.*

The first diagram gives curves of counter-radiation from atmosphere based on $\sigma T^4(0{\cdot}82-0{\cdot}25\times10^{-0{\cdot}126e})$, e = v.p. in mm. The second gives long-wave radiation from a horizontal black surface and the third gives correction factors for different amounts of various cloud types. METEOROLOGICAL ABSTRACTS

551.591.1

4810. On the meteorological optics of haze and fog. I. L. FOITZIK. *Z. Met.*, **4**, 289–97 (*Oct.*, 1950) *In German.*

Loss of light passing through water drops is expressed in two equations, for constant drop radius and constant wavelength, after Stratton and Houghton. An expression for opaque particles is given by Gotz. Visibility and extinction are plotted in terms of radius, refractive index and wavelength; a sharp minimum extinction occurs between 0·7 and 1·5 μ in theory and observation. According to author's abstract, Pt II will show that natural haze and mist can be regarded as mixtures of water drops with radii distributed according to Gauss' law of errors, functions are developed applicable to average and extreme distributions, and the values of the constants are tabulated. METEOROLOGICAL ABSTRACTS

551.593.52 : 535.343.4

Atmospheric transmission at high temperatures. *See Abstr.* 4246

551.593.53

4811. The relation between the scattering of light in the atmosphere and wavelength. E. V. PYASKOVSKAYA-FESENKOVA. *Dokl. Akad. Nauk SSSR*, **80**, 595–8 (*No.* 4, 1951) *In Russian.*

In addition to measurements reported previously [Abstr. 2377 (1952)], measurements were made on the brightness of the day sky with a visual photometer provided with Schott filters for blue, green and red. At the same time the brightness of a screen with known albedo, illuminated by the sun was measured. It is assumed that μ (the ratio of scattered light falling on unit solid angle to the total incident light) can be related to λ by the equation $\mu = C\lambda^{-n}$ . . . (1) and if C and n are independent of λ, by $lg\mu = 1gC - n\,lg\lambda$ . . . (2). In the part of the spectrum investigated, graphs of μ against λ can be represented by (2) where n is independent of λ, if dry particles do not play a dominating role in the scattering. In the opposite case for small θ (the scattering angle) the values of n depend on θ and can be in certain regions < 0. Values of n are given in tabular form for three days for different θ. The scattering of light cannot therefore be co-ordinated with particles of average size with certain definite effective radius, since the average weight radius of the particles for small θ is determined chiefly by coarse aerosols and for large θ by molecules. In so far as n characterizes the radius of the scattering particles, therefore the increase of n with θ, as the results show, confirm the theory advanced, and determine the change of the dark blue colour of the sky with changing θ. W. HUGHES

551.593.9

4812. Identification of the night-sky spectrum around 10 000 Å. V. I. KRASOVSKIĬ AND V. T. LUKASHENYA. *Dokl. Akad. Nauk SSSR*, **80**, 735–8 (*No.* 5, 1951) *In Russian.*

Discusses 2–3 spectrograms of the night-sky spectrum near 10 000 Å taken with a spectrograph having a dispersion of *c.* 175 Å/mm and a resolving power down to 5 Å, and showing many new details and blackening in all spectrum portions. The authors enlarge upon the theory of the excitation mechanism of the night-sky radiation, developed by Krasovskiĭ [Abstr. 3597, 7648 (1950), 6644 (1951)]. The initial excitation is due to a ternary collision resulting in the formation of the excited molecules of O'_2, NO', N'_2, O'_3 and N_2O'. F. LACHMAN

551.593.9

4813. Characteristics of the night-sky at College, Alaska. J. B. - WILCOX. *Mixed Commission on Ionosphere, Brussels* (1950) 81–4. [See Abstr. 4798 (1952)].

Data on brightness determinations of the night-sky obtained during the months of January, February and March 1950 are used to calculate a mean height for a single "equivalent" emitting layer. The value deduced is 600 km. W. J. G. BEYNON

551.594.13

4814. On the electrical conductivity of the upper atmosphere. K. MAEDA. *Mixed Commission on Ionosphere, Brussels* (1950) 215–27. [See Abstr. 4798 (1952)].

Discussion of problems of ion/electron ratio, collisional frequency, electrical conductivity and the day-to-night variations in these quantities.

W. J. G. BEYNON

551.594.6 : 621.396.821

4815. The waveforms of atmospherics. P. G. F. CATON AND E. T. PIERCE. *Phil. Mag.*, **43**, 393–409 (*April*, 1952).

A convenient and economical technique for recording the waveforms of atmospherics is described, a time resolution of 3 μsec being achieved with a photograph of total duration, 20 msec. The character of the main waveform types observed at Cambridge was examined with particular reference to the effects of the distance and direction of the originating lightning discharges. At night, the type of waveform observed depends upon the geographical location of the source; for storms to the south-west, a transition

in waveform type occurs at a distance of about 1600 km; no similar change is observed for sources in a south-easterly direction. A critical discussion is given of the applicability of the theory of multiple ionospheric reflections to the various types of waveform, and of the accuracy with which the effective height of reflection and the distance of the source can be determined. Only a small proportion of atm spherics recorded, rarely more than 10% on any o night, yield precise values of these quantities; t height of reflection is found to be about 85 km. T smooth regular oscillatory type, originating beyo 1600 km to the south-west, cannot be explained by straightforward application of the reflection theory.

BIOLOGY 57/59

578.088.5

4816. Determination of the sensitive volume by irradiation and the ionization density. I. OPATOWSKI. *Bull. Math. Biophys.*, **13**, 263–71 (*Dec.*, 1951).

Lea's formula for the determination of size of the sensitive volume is corrected and applied to experiments on inactivation of the tobacco mosaic virus using 3 different wavelengths of X-rays. The purely geometric concept of the sensitive volume is not sufficient for explaining the known dependence of the inactivation of this virus on wavelength. The concept of transfer of energy around the ionizing particles is discussed in this connection in a manner similar to that suggested by Pollard and Forro for the inactivation of the $T-1$ phage, and results similar to those given by these authors are obtained from an analysis of the inactivation data of J. W. Gowen (tobacco mosaic virus). Differences of interpretation of these two sets of experiments carried out with different types of radiation are pointed out. A.

578.088.5

4817. Diffusion and recombination of products of ionizing radiations. I. OPATOWSKI AND F. R. TANGHERLINI. *Bull. Math. Biophys.*, **13**, 273–88 (*Dec.*, 1951).

The relative importance of diffusion and recombination of the products of ionizing radiations is examined in several typical cases and methods for the solution of the differential equation of columnar ionization are discussed. It is shown that Jaffe's method is not applicable to radiobiological or purely radiochemical processes in which no external electric fields are acting. A method based on a recent suggestion of Kramers appears to be particularly good when recombination is strong. A.

578.088.5 : 534.321.9

4818. Application of echo-ranging techniques to the determination of structure of biological tissues. J. T. WILD AND J. M. REID. *Science*, **115**, 226–30 (*Feb.* 29, 1952).

A narrow beam of 15 Mc/s pulsed ultrasonic energy, directed into tissues, will produce echoes corresponding to the variations in tissue structure, the results being analogous to those obtained by needle biopsy. By providing a movement through 45° for the generating piezo-electric crystal, an area of skin and underlying tissue is scanned, and the echoes received are synchronized and recorded on a cathode-ray screen. A two-dimensional "echogram" is thus produced. The apparatus has passed the developmental stage; schematic diagrams and photographs are shown. A detailed description of the production and interpretation, with experiment tissue, of a two-dimensional "echogram" is give A limited clinical trial is described. D. V. MABB

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 6

612.014.462.481 : 519.

4819. A probability model of radiation damage A. T. REID. Letter in *Nature* [*Lond.*] **169**, 369–7 (*March* 1, 1952).

Uses Markov chains to construct a model o causation of damage to biological systems.

N. L. JOHNSON

612.15 : 539.16.08

4820. An instrument for the measurement of cardiac output. S. R. POWERS, H. H. ROSSI AND E. M. PAPPER. *Rev. Sci. Instrum.*, **23**, 178–81 (*April*, 1952).

A modification of the injection technique for the determination of cardiac output is presented in which the injected material is a radioactive isotope (Na^{24}). The measurement is performed with a recording unit which consists of a counting chamber, a counter with conventional amplifier, a count rate circuit with a short RC constant (1 second), and a recording milliammeter. The instrumentation is described and a simple method is given whereby the cardiac output may be determined from the trace of the recorder. A.

612.843.2

4821. Alleged effects of the near ultraviolet on human vision. G. WALD. *J. Opt. Soc. Amer.*, **42**, 171–7 (*March*, 1952).

It has been reported that short exposures of the human eye to near ultraviolet radiation in the wavelength range 290–365 mμ produce appreciable changes in subsequent dark adaptation, and a lasting depression of visual sensitivity, rod and cone. These reports are hard to reconcile with the fact that only traces of such radiation reach the retina. Wavelengths shorter than 300 mμ are absorbed by the cornea of the eye, and they can do damage; longer wavelengths up to 400 mμ are absorbed in the lens. The assertion that such radiations affect the visual sensitivity is re-examined in the present paper. Exposures to ultraviolet light identical with those referred to produce no appreciable effects on subsequent dark adaptation of the normal eye, rod or cone. In lensless (aphakic) subjects, near ultraviolet radiation in the neighbourhood of 365 mμ does reach the retina and is clearly

ible. Even in such persons, exposure to the near raviolet does not affect the threshold of rod vision er 20 minutes of dark adaptation. The early rtions of dark adaptation—the adaptation of the nes, and sometimes also the early rod thresholds—ay be raised; but these changes are caused, not by rinsic effects of the ultraviolet, but by the increased ightness to which it gives rise in the aphakic eye. is concluded that ultraviolet radiations which ght harm the retina do not reach it; those which ach the retina do it no harm, and can at most be en. A.

612.843.3

22. Limits of the visible spectrum. M. H. RENNE. *Research* [*Lond.*] **4,** 508–15 (*Nov.*, 1951).

The spectral distribution of solar radiation and uman rod and cone thresholds at various wave-ngths are discussed. The thermal radiation in the e is calculated and it is shown that, in the absence selective photochemical activity in the eye, the ly visible object would be the sun. An appreciable sual sensitivity at $\lambda > 1\,\mu$ would be obnoxious cause of the spectral distribution of black-body diation at 37°C. The ultraviolet limit is connected ith the dispersion of the pre-retinal structures; it is uch lower in insects whose eyes are built on a fferent principle. 6 figs. are given. R. A. WEALE

612.843.31

823. Green vision and binocular fusion of yellow. A. TALBOT; L. M. HURVICH AND D. JAMESON. etters in *Science*, **115,** 220–1 (*Feb.* 22, 1952).

Hurvich and Jameson's recent claim [Abstr. 9867 951)] to have proved the existence of a "yellow" tinal receptor is criticized because (1) the red and een used by them do not produce yellow when ixed monocularly; (2) the vast majority of observers onsider a non-blue and non-yellow green to lie well n the long-wave side of 495 mμ as used by Hurvich nd Jameson; (3) various criteria for "unique" green ave been used, and confused by them; (4) "binocular" ellow looks as saturated as spectral yellow. Consequently yellow cannot be only of retinal origin.

In reply, Hurvich and Jameson reject all these riticisms and unrepentingly adhere to their original iew. R. A. WEALE

612.843.31

824. Light and dark adaptation and the perception f color. R. W. G. HUNT. *J. Opt. Soc. Amer.*, **42,** 90–9 (*March*, 1952).

A description is given of an apparatus which has een constructed for the purpose of investigating, by eans of the binocular matching technique, the anges in colour perception which arise when the ate of adaptation of the eye is altered. The changes colour perception, consequent upon changes in e intensity of the adapting light in 7 steps from ero to 100 candles per ft², have been investigated for vo observers. The adapting field size was 60°; the st-field size was 20°. There was found a gradual ecrease in the saturation of colours as the adapting ght intensity was lowered. At low levels, the aturation increased with increasing test-colour ntensity; but at high levels, increasing test-colour intensity caused most colours to become bluer. The sensation corresponding to dim light seen by the dark-adapted eye was found to be pale blue, and not colourless. A final section considers the problem of how the activity of a fourth "white" receptor mechanism might be reconciled with trichromatic matching, and in particular with the constancy of monocular colour matches with changes in adaptation. A.

612.843.53

4825. Observations of stellar scintillation. H. E. BUTLER. *Proc. Roy. Irish Acad. A*, **54,** 321–40 (*No.* 20, *May*, 1952).

A detailed account is given of the photoelectric recording apparatus fitted to a 15-in reflecting telescope. A Fabry lens is employed to focus the mirror on to the photoelectric cell (IP21). Both galvanometric and oscilloscopic recordings were made, which are shown in 13 well-produced plates. Recordings were obtained for different elevations with 4-in and 15-in apertures, the latter yielding more consistent results: the "upper limit of scintillation" is maximal at 0° and drops to its 90° value at about 35°. The intensity distribution is sharper for lower elevations. The results are compared with data obtained on street lamps, and a qualitative discussion is presented. 8 figs. are given. R. A. WEALE

612.843.612

4826. Differential intensity thresholds of two luminous points. F. FLAMANT. *Rev. Opt.* (*Théor. Instrum.*) **31,** 113–20 (*March*, 1952) *In French.*

An apparatus is described for studying the smallest perceptible difference ΔI of the intensities of two very close luminous points which together give at the pupil of the eye an illumination of about 10^{-4} lux. The sensitivity is measured for a variable separation of the points in foveal vision, then for a variable position of this pair of points on the retina. In this latter case measurements have been made not only in white light but also in blue, green and red. If I is the greater of the two intensities, the variation $\Delta I/I$ over the retina is compared with the curve of visual acuity in white light and also with that which, according to Osterberg, gives the distance between the cones. A.

612.843.72

4827. Space perception and vertical disparity. L. I. EPSTEIN. Letter in *J. Opt. Soc. Amer.*, **42,** 145 (*Feb.*, 1952).

It is suggested that the well-known alley experiment should be repeated with pairs of dots instead of single dots so that vertical disparity be allowed to play its normal role in space perception. R. A. WEALE

612.843.72

4828. Space perception and vertical disparity. K. N. OGLE. Letter in *J. Opt. Soc. Amer.*, **42,** 145 (*Feb.*, 1952).

The presence of a limited amount of vertically spaced detail has not made it possible to account for the failure of the apparent to agree with the objective fronto-parallel plane. Epstein's suggestion (preceding abstract) is not likely to solve the problem, pointed out by him, because the horizontal dominates over the vertical disparity. R. A. WEALE

612.843.721

4829. A criticism of the use of the word "anisopia." K. N. OGLE. Letter in *J. Opt. Soc. Amer.*, **42**, 142 (*Feb.*, 1952).

This word should be used to describe only the anomaly in the binocular visual process in which there exists "a difference in magnification between the images for the two eyes." Cibis and Haber's use of the word to describe aniseikonia and the accompanying effect on binocular space perception is deprecated.

R. A. WEALE

612.845.1

4830. Accommodation and night myopia. J. M. OTERO AND M. AGUILAR. Letter in *J. Opt. Soc. Amer.*, **41**, 1061–2 (*Dec.*, 1951).

Measurements carried out on 5 observers show that night myopia is practically constant when the (artificial) pupil diameter is changed from 2 to 7 mm. One graph is given. R. A. WEALE

612.846

4831. Rotation of the eyes during involuntary blinking. B. L. GINSBORG. Letter in *Nature* [*Lond.*] **169**, 412–13 (*March* 8, 1952).

See also Abstr. 1970 (1948).

612.85

4832. Auditory perspective—a study of the biological factors related to directional hearing. H. G. KOBRAK. *J. Soc. Mot. Pict. Televis. Engrs*, **57**, 328–35 (*Oct.*, 1951).

The biological principles of auditory localization for stereosound reproduction are discussed. The attributes of the acoustic signal relevant to sound localization and the role of the central nervous system in the integration of binaural stimulation are described. The paper discusses the combined senses of vision and hearing. Very good illustrations of the cochlea and inner ear are reproduced. A. B. WOOD

612.85

4833. Delayed speech feedback as a test for auditory malingering. W. R. TIFFANY AND C. N. HANLEY. *Science*, **115**, 59–60 (*Jan.* 18, 1952).

An investigation is described in which the subject under test, suspected of auditory malingering (feigning deafness), is supplied aurally by delayed feedback speech. The subject reads a passage three times from a book which is recorded on tape. In one of the readings this is played back through headphones with the appropriate time delay. In a normal subject the feedback would cause a reduction of the oral reading rate, but in a genuinely deaf subject the feedback, unheard, would make no difference to the reading rate. The method has been proved to be feasible as a means of detection of malingering, and/or psychogenic deafness. A. B. WOOD

612.85

4834. The place principle in auditory theory. E. G. WEVER AND M. LAWRENCE. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 133–8 (*Feb.*, 1952).

A comparison is made of the resonance theories (or "local action" or "place" theories) and the travelling wave theories of functioning of the cochlea. Experiments are described in which sound arriving the ear from a loudspeaker via the oval windo interferes in the ear with vibrations of the san frequency excited directly through a minute hole the cochlear capsule in any location. As a result these experiments it is concluded that the travelli wave theory is untenable, whilst the results gi definite support to the place theory. A. B. WOO

612.85 : 534.77

Audiometric measurement of hearing loss. *S Abstr.* 4195

612.85 : 621.3.012.8 : 621.38

4835. Signal translation in hearing. L. O. SCHOT *Bell Lab. Rec.*, **30**, 2–8 (*Jan.*, 1952).

The mechanism of the human ear and the construc tion of an electrical circuit analogue of a single ha cell is described. A cross-section of the ear is give with a magnified picture of this electric pulse generat ing cell of which there are 15 000 on a 1¼-in lengt of the basilar membrane. A thyratron relaxation sawtooth oscillator operates from several times pe sec for weak signals and limited to 1 000/sec for ver strong signals to conform with observations that a nerve fibre has an "absolute refractory" period o 0·001 sec. The signal stimulus is provided by a sine-wave oscillator. Two c.r.t.'s are provided; one shows the pulses generated in response to the stimuli, and the other shows the input signal, with the pulses superposed to show in what part of the signal waves the pulses occur. With results obtained from this set-up, patterns have been constructed to show the picture which the brain will recognize as corresponding to a particular sound. A number of these patterns are given, together with a diagram of the "hair cell" circuit and its characteristic.

B. B. AUSTIN (R)

614.898

4836. The use of small protection films for the estimation of the doses received on the fingers and hands during radium manipulations. T. M. ROBB AND R. E. ELLIS. *Brit. J. Radiol.*, **25**, 100–2 (*Feb.*, 1952).

614.898

4837. The evaluation of white-cell counting in radiation protection. A. C. CHAMBERLAIN, F. M. TURNER AND E. K. WILLIAMS. *Brit. J. Radiol.*, **25**, 169–76 (*April*, 1952).

In Pt I the causes and extent of normal variations in the total white cell count, and the lymphocyte and neutrophil count, are considered. Physiological variations are very big, the coefficient of variation in an individual leucocyte count due to this cause over long periods being about 20%. In Pt II the variations to be expected from acute and chronic radiation are considered in relation to the other variations. Results in the literature and at A.E.R.E. are examined for evidence of discernible effects. It is concluded that white cell counting does not give the measure of protection to an individual implied in the Recommendations of the British X-ray and Radium Protection Committee. There is, however, some evidence of detectable radiation effect on the average count of large groups of workers, even at the low levels maintained at A.E.R.E. A.

615.849 : 537.534.75

38. Radiological use of high energy deuterons and ha particles. C. A. TOBIAS, H. O. ANGER AND H. LAWRENCE. *Amer. J. Roentgenol. Radium er.*, **67**, 1–27 (*Jan.*, 1952).

A review of some of the physical properties of the diations, dosage determination, biological use and tential medical applications of 190 MeV deuterons m the Berkeley 184-in f.m. cyclotron. It is shown at the deuteron beam has unique radiological operties: straight and deep penetration in tissue th small scattering and maximum dose near the d of the range of the beam. The deuteron beam is itable for effective and intense irradiation of small lumes deep within the body of animals or humans. etailed accounts of measurements of the ionization, nge, stopping power and dosimetry of the ion beam e given and possible application to radiotherapy is dicated. T. A. CHALMERS

615.849 : 539.16.08

39. Estimation of dosage for intravenously lministered P^{32}. Calculation based on two compart-ent distribution of the isotope. B. V. A. LOW-BEER, . S. BLAIS AND N. E. SCOFIELD. *Amer. J. Roentgenol. adium Ther.*, **67**, 28–41 (*Jan.*, 1952).

It is shown that the differential concentration of the otope between soft tissues and bone–spleen–liver ssues makes it advisable to calculate the radiation ose in these two compartments separately. The ose in these two compartments is referred to as bone" dose and "soft tissue" dose respectively. vidence is presented from experimental data which justifies the assumption that after a three-day "equilibration" period the concentration ratio between the "bone" compartment and "soft tissue" compartment is 10 : 1. Taking into account the concentration changes in the first three days this results in a "bone" to "soft tissue" dose ratio of 9 : 1. The charting, treatment, and the practical use of special dose-record forms is presented, and the derivation is given of the formulae used in the dose calculations based upon the two-compartment distribution of P^{32}. T. A. CHALMERS

615.849 : 616.006.4

4840. Applications of physics in the diagnosis and treatment of cancer. *Nature* [*Lond.*] **168**, 1023–5 (*Dec.* 15, 1951).

Summaries, in about 250 words, are given of the following papers, read at a symposium held by the Physical Society in October 1951 at the Royal Cancer Hospital: "*The use of high energy particle accelerators*" (D. A. Layne) concerned the preparation for clinical use of a 30 MeV synchrotron. "*The use of radioactive isotopes*" (W. K. Sinclair) outlined the clinical and physical techniques employed. "*Electronics*" (R. C. Turner) indicated the trend of instrumentation. Experimental and routine use of scintillation counters was described in "*Scintillation counting*" (E. H. Belcher). "*Photographic measurements for ionizing radiation*" (G. Spiegler) gave quantitative results for various qualities of radiation. The concluding paper was "*Autoradiography*" (L. F. Lamerton). No references are given. D. V. MABBS

PHOTOGRAPHY 77

771.5

841. Elimination of contraction in nuclear emul-ons. G. MIGNONE. Letter in *Nuovo Cim.*, **8**, 96–7 (*Nov.*, 1951) *In Italian.*

The normal contraction of the emulsion after pro-essing may be partly or wholly eliminated by im-ersion in a glycerine solution of appropriate oncentration. S. T. HENDERSON

771.53

842. On a primary photographic effect produced y the combined action of X-rays and light. H. ELLEZ-PLASENCIA. *C.R. Acad. Sci.* [*Paris*] **234**, 06–8 (*Jan.* 7, 1952) *In French.*

Sections of a plate of unsensitized AgBr emulsion ere exposed to X-rays of wavelength 0·22 Å and ntensity 0·03 r per sec for times between 8 sec and hr. The whole plate was then exposed for times etween 5 min and several hours to light of intensity 00 lux. This double exposure produced images ithout development up to a density of 0·3 above he background, a maximum occurring at 20–50 r. o effect was apparent with exposure to light before -rays. With AgCl emulsions similar results were ound, except at high intensities, when exposure to ght only gave greater densities than the combined adiation. The behaviour of the AgBr emulsion owards $NaNO_2$, CrO_3, alkali iodide and $Na_2S_2O_3$ is escribed. S. T. HENDERSON

771.534

4843. Properties of the photographic emulsion at various temperatures. A. L. KARTUZHANSKIĬ AND P. V. MEĬKLYAR. *Zh. Eksper. Teor. Fiz.*, **21**, 693–700 (*No.* 6, 1951) *In Russian.*

The investigation was conducted at different temperatures (from −180 to +66°c), and for different conditions of continuous and intermittent illumination. Lower temperature causes the increase of the optimum exposure time corresponding with the maximum sensitivity of emulsion, and stretches and flattens the curve of equal opacity. In the case of intermittent illumination, lowering of temperature causes an increase of the optimum number of light impulses, corresponding with the maximum sensitivity of emulsion. Temperature dependence of the emulsion sensitivity in the case of continuous illumination differs quantitatively from that in the case of intermittent illumination. F. LACHMAN

771.534

4844. The dependence of photographic sensitivity on temperature. G. C. FARNELL. *Phil. Mag.*, **43**, 289–305 (*March*, 1952).

A preliminary survey is first presented of the factors which have been suggested to account for the generally observed decrease in sensitivity of a photographic emulsion on lowering its temperature to that of liquid

N. It is concluded that the main problem to be resolved is whether, after due allowance for the decreased absorption of the halide, the observed speed loss can be completely assigned to the effective high intensity reciprocity failure of the low temperature exposure, or whether some additional mechanism of exposure wastage comes into play. Experiments are then described, the results of which show that for a range of emulsions the observed speed loss on passing from room to liquid N temperature can be quantitatively accounted for in terms of decreased absorption of the halide and the fact that low temperature exposures are essentially of very high intensity. The fluorescence of bromo-iodide emulsions whilst undergoing a low temperature latent-image exposure is apparently not connected with the speed loss, but is merely a visual manifestation of the recombination which is occurring in an unobservable manner at room temperature. Finally the results of other investigators are discussed in the light of the new findings; several pieces of evidence emerge which confirm their generality. A.

771.535

4845. The fading of the latent image in silver bromide emulsions. W. HÄLG AND L. JENNY. *Helv. Phys. Acta*, **24**, 508–16 (*No.* 5, 1951) *In German.*

The fading of the latent image produced by α-particles and protons has been investigated in silver bromide emulsions manufactured by the authors. The analysis of the number of developed grains as a function of the time interval between exposure and development leads to the assumption of a long- and short-lived component of the latent image. A comparison with light exposures shows that the long-lived component increases with the energy absorbed by the grains. Hydrogen peroxide accelerates the rate of fading of the short-lived component to a greater extent than the long-lived component. An attempt is made to correlate the results with the latent image distribution. A. C. COATES

778.3

4846. Intensification of X-ray diffraction films to increase speed. G. M. CORNEY AND H. R. SPLETTSTOSSER. Note in *Rev. Sci. Instrum.*, **23**, 98–9 (*Feb.*, 1952).

Reproductions of Debye–Scherrer photographs show the effect of intensification after an exposure time of one-quarter of the normal. Formulae for an intensifier are given. A. R. STOKES

778.3 : 535.247

4847. On photometry in thick nuclear emulsions. M. CECCARELLI AND G. T. ZORN. *Phil. Mag.*, **43**, 356–66 (*March*, 1952).

Photometric methods of determining the ionization produced by a charged particle in passing through nuclear emulsions are discussed, and a technique based on measuring the mean width of a track is described. The method has been tested by applying it to a study of the heavy primary component of cosmic radiation. It is concluded that the photometry of tracks produced by charged particles passing through electron-sensitive emulsions may be used as a sensitive measure of the specific ionization for values of the rate of loss of energy less than 30 MeV/g/cm², and greater than 200 MeV/g/cm². Similar methods can also be applied for identifying multiply charged particles, if they are arrested in the emulsions, and if the length of their tracks exceeds 200 μ.

778.3

4848. Microradiography of microfossils with X-ray diffraction equipment. R. A. M. SCHMIDT. *Science*, **114**, 94–5 (*Jan.* 25, 1952).

A converted X-ray diffraction unit is used to produce these microradiographs. Interchangeable tubes, each with a different target metal, allow a range of sensibly monochromatic X-ray beams. This method is convenient for showing the internal arrangement of foraminiferal chambers and muscle scar patterns, without causing harm to the specimen. Details of mounting specimens are given, and plates shown comparing microphotographs and the corresponding microradiographs. D. V. MABBE

778.3

4849. Sensitometer for very short exposures. H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **20**, 634–8 (*Nov.*, 1951) *In French.*

A description of apparatus by which emulsions may be exposed for times between 1 μsec and 0·6 sec. It includes a rotating mirror and system of disks driven by electronically controlled motors. S. T. HENDERSON

778.6

4850. Color film analysis from integral density data. M. H. SWEET. *J. Opt. Soc. Amer.*, **42**, 232–7 (*April*, 1952).

By using the relationship between the spectral densities of specimens of a given kind of colour film at three separated wavelengths and their chromaticities, integral colour densitometer data can be correlated with dominant wavelength and purity data. Transformation grids are prepared to facilitate this conversion. Colour film balance can be represented by a series of vectors, each drawn from different density levels along a density *v.* log exposure curve. The vectors represent, by their directions, the dominant wavelengths of the corresponding grey-exposed patches of the sensitometric strip and by their lengths, the extent of the departure from grey balance. For any particular case, a grid can be prepared which relates the vectors to the corresponding Munsell colours of the patches. In a similar way, the correlation between the vectors and the filtration of the light source necessary to correctly reproduce grey can be established and utilized in grid form. Although developed primarily for three-layer reversible colour film, the treatment is applicable to any three-colour reproduction process. A.